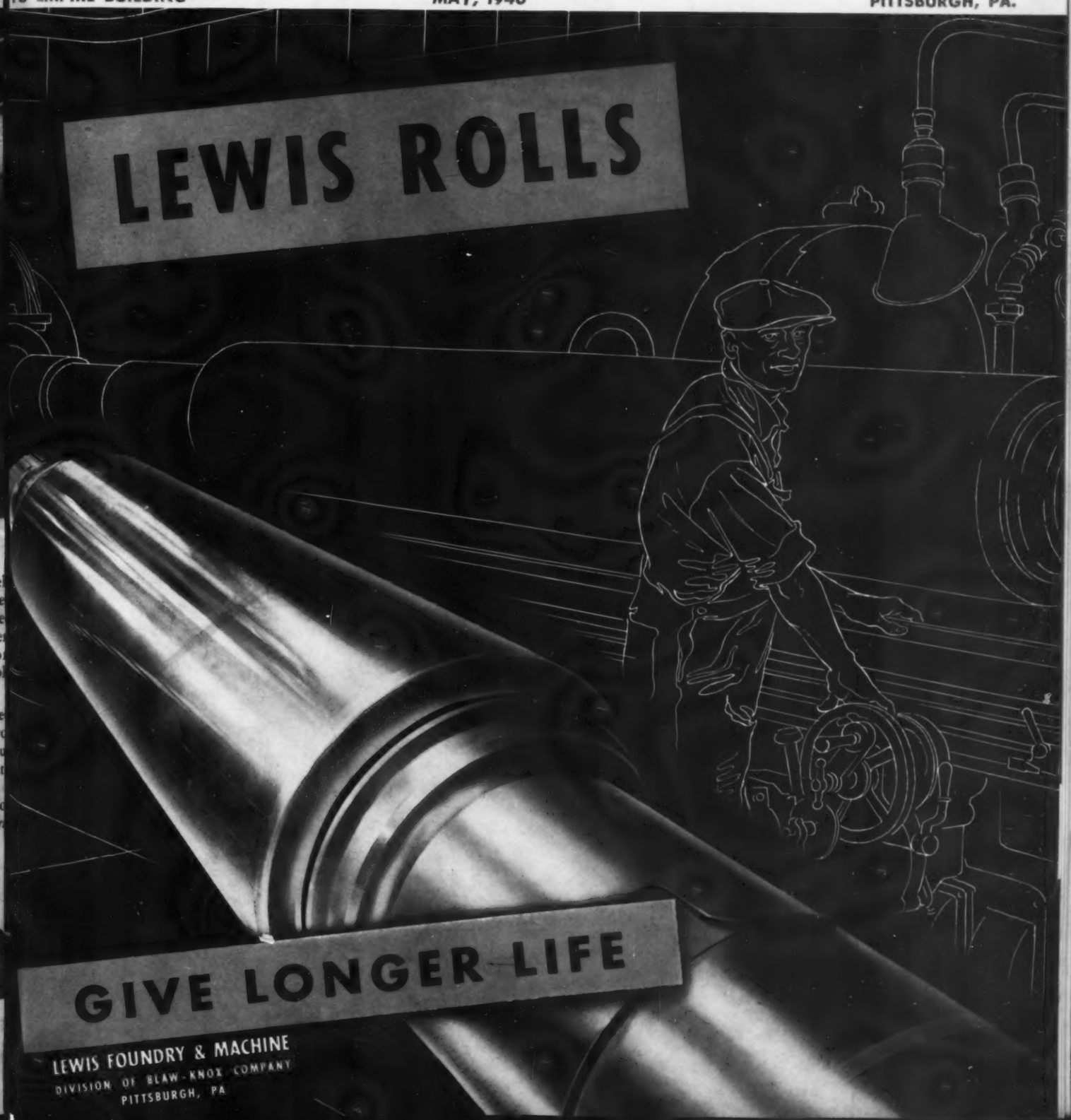
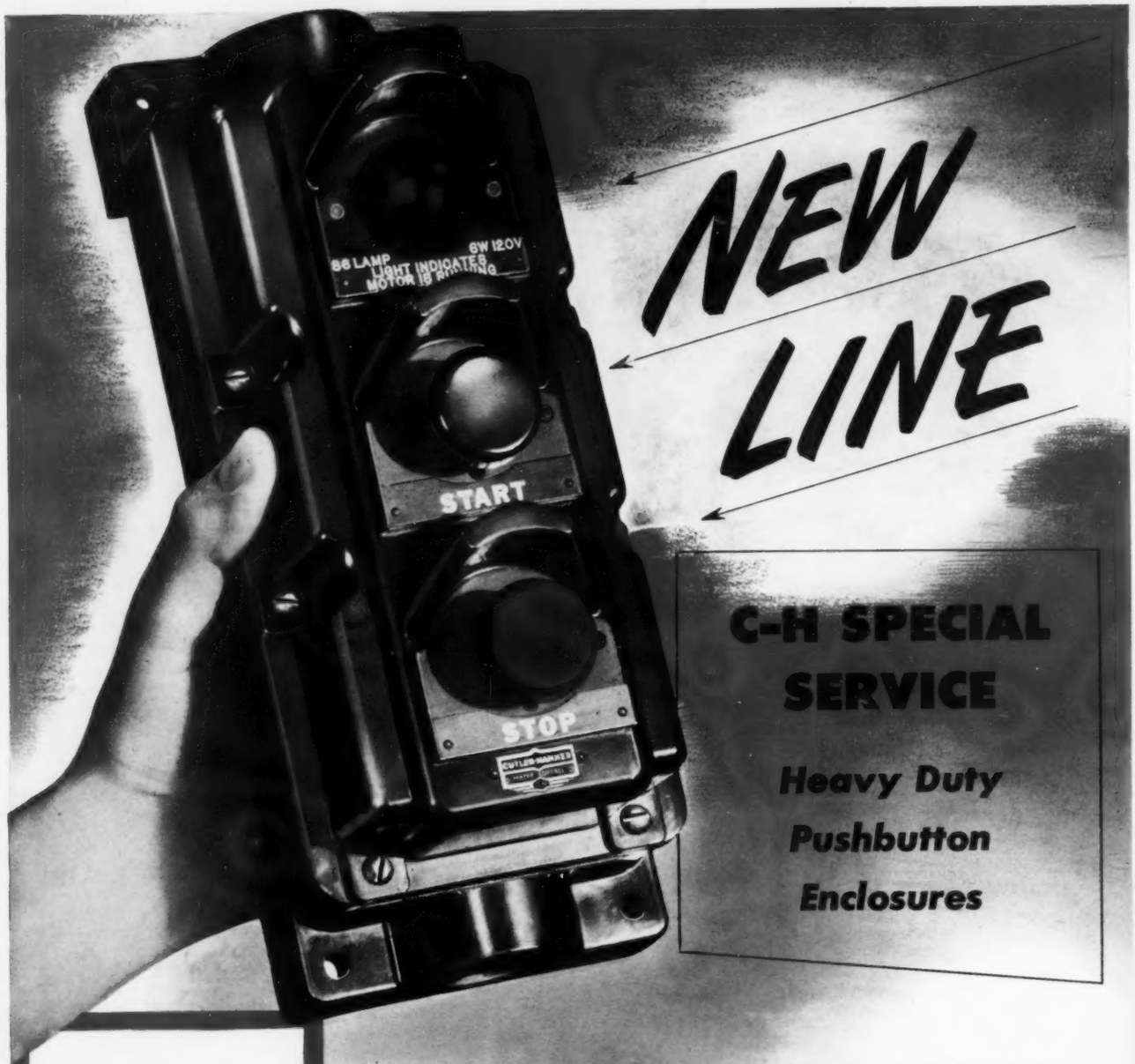
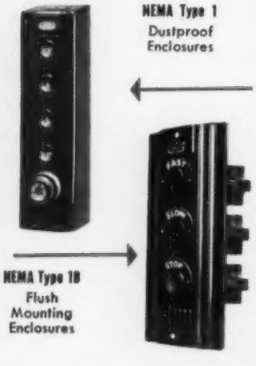
Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

10 EMPIRE BUILDING | MAY, 1946 | PITTSBURGH, PA.







Also a complete line of one-hole and base mounting elements without enclosure.

NEMA 4 Water-tight
NEMA 5 Dust-tight
NEMA 7 For hazardous Vapors
NEMA 9 For hazardous Dust
From 1 to 6 Heavy Duty Elements

Also Oil-tight Construction

Oil-tight construction that really keeps oil out. Oilproof Neoprene gaskets positively prevent oil seepage.

Cutler-Hammer now offers a broad range of pushbutton stations and pushbutton elements for special service of every kind.

Typical of the line, the oil-tight stations conforming to automotive and machine tool standards, offer superlative engineering. *Oilproof* Neoprene gaskets positively seal out oil; large rugged terminals abolish the need to form a loop in wiring; oversize mushroom type operating buttons with drip-hoods and guard flanges . . . these are just a few of the scores of construction, operation and installation superiorities that show why machine builders and machine users prefer Cutler-Hammer pushbutton elements and stations and say they have no equal. Write for full information today. CUTLER-HAMMER, Inc., 1261 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER-HAMMER
MOTOR CONTROL
C-H

NEW PIERCER OUTLET TABLE

ROTATING BAR AND TUBE GUIDES

Operating men have been talking for years about an outlet table using only one set of guide rolls to do two jobs. They prodded engineers into developing the idea and here it is.

As pierced tube approaches mandrel guide — guides automatically open up in sequence to serve as tube guides.

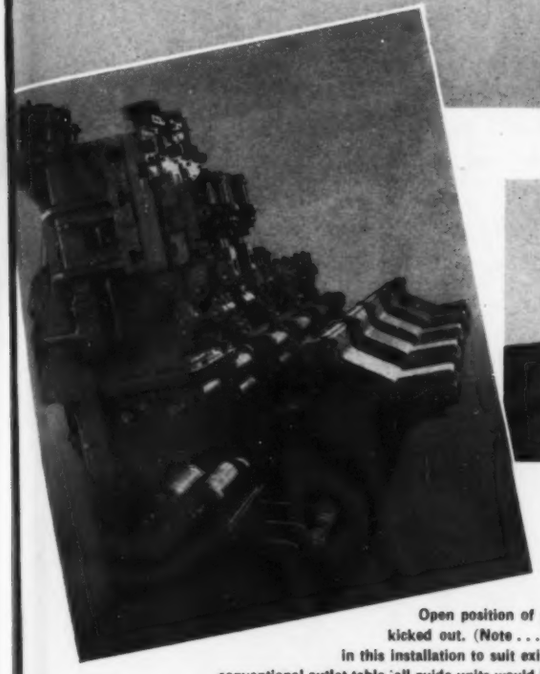
A size change is easy as 1-2-3. One man, without crane service or extra man power, makes a size change in a few minutes. He simply adjusts by calibrated indicator.

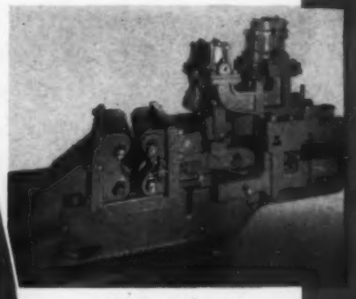
Full length support from thrust block to piercer point eliminates play or whip and cuts down on wear and tear of equipment. All this results in better concentricity, more uniform wall, and improved outside finish . . . a better product.

Ask for complete information. Designed by Aetna-Standard, world's foremost builder of seamless tube and continuous buttweld pipe mills.

THE AETNA-STANDARD ENGINEERING CO.
YOUNGSTOWN, OHIO

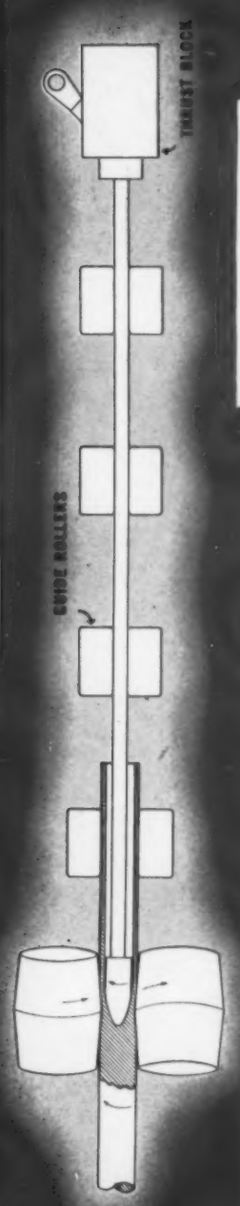
ASSOCIATED COMPANY
HEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND





Closed position for guiding mandrel bar.

Open position of guide units ready for tube to be kicked out. (Note . . . first vertical guide unit required in this installation to suit existing piercing mill clearances. On conventional outlet table, all guide units would be horizontal type.)



FEATURES OF NEW PIERCER OUTLET TABLE

One set of rollers covers range from 2¾" mandrel bar up to 9⅝" O.D. tube.

No extra guides necessary for extra sizes.

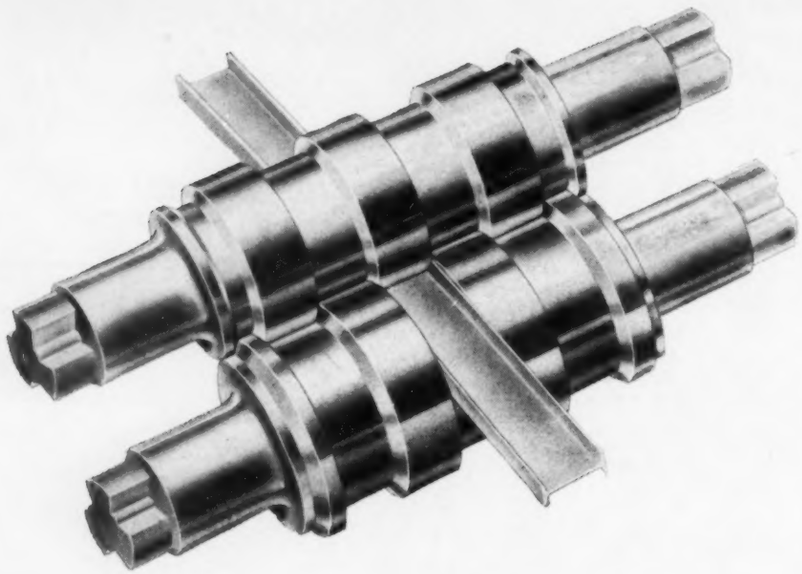
Size change set up by one man without crane service.

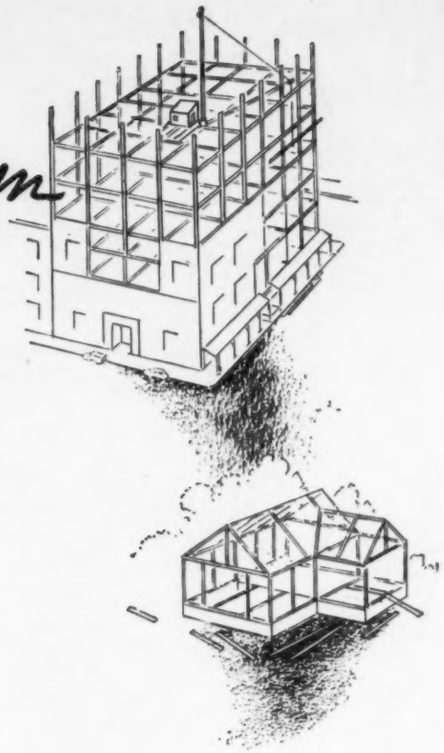
Mandrel bar supported entire length from thrust block to piercer point.

DESIGNERS and BUILDERS to the Steel, Non-Ferrous and Chemical Industries

Aetna-Standard

RIGHT *on the beam*





● Beam forming rolls promise to be in heavy demand in the near future. Steel beams in many shapes will be required for the anticipated boom in both heavy and light construction. No matter what the beam profile or gauge, National is prepared to produce speedily rolls that are *right* for the purpose.

National has the engineering talent, the modern manufacturing facilities and the highly necessary metallurgical research experience to expertly cast and machine whatever rolls the steel industry may require.

From past experience, users everywhere know that on the basis of tonnage formed and long service life, National Rolls compile enviable records. We invite immediate inquiries.

NATIONAL ROLLS

National Rolls

THE NATIONAL ROLL & FOUNDRY CO.

AVONMORE, PENNSYLVANIA

Manufacturers of: ALL GRADES OF CAST ROLLS • IRON & ALLOY IRON STEEL & ALLOY STEEL • HEAVY IRON & STEEL CASTINGS • ROLLING MILL EQUIPMENT

NEW DATA ON
Quick-As-Wink
CONTROL VALVES

Just Off the Press!

Quick-As-Wink
Control Valves
THE HIGHER THE PRESSURE
THE TIGHTER THE SEAL
For AIR • WATER • OIL
MANUFACTURED BY C. B. HUNT & SON, INC. SALEM, OHIO
BULLETIN 107

Twelve easy-to-read pages packed with factual data on control valves. Data you can use almost daily. Authentic information about Hunt control valves, complete with sizes, actions, and illustrations. A bulletin designed for the man who buys or specifies valves. No history of the company, no space-filling blurbs . . . just data you can put to use in writing up an order or specification.

*We are ready to mail your copy promptly upon request.

SUMMARY OF DATA

Description of Operating Units for Machine Designers.
Features of Quick-As-Wink Control Valves.
Air Valves (foot, hand, diaphragm, solenoid operated).
Hydraulic Valves (lever, and pilot operated).
Descaling Valve (how it works . . . what it does).
Single Plunger (solenoid, mechanical, lever, diaphragm, cam, palm, and pilot cylinder operated).
Swing, Rotating, Ball Bearing Joints.
Valve and Hose Couplings.
Roll Cooling Equipment.

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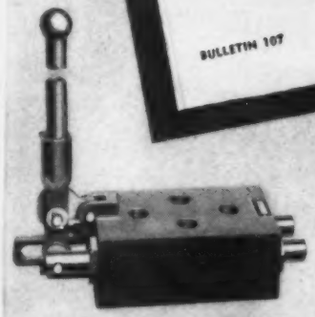

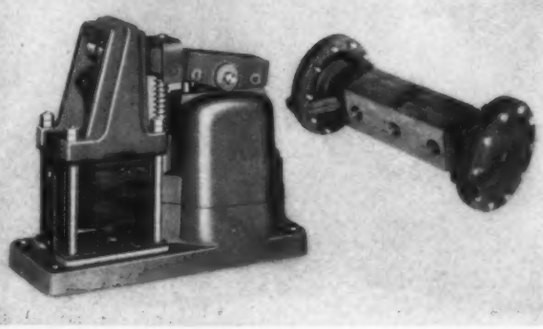

C. B. HUNT & SON, Inc. SALEM, OHIO

*Please send us copy of Bulletin 107

NAME_____

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HEAVY DUTY D-C CONTROL

Uninterrupted Production is vital in mills where steel is processed in closely integrated steps. SQUARE D's heavy duty D-C control meets mill electrical standards and contributes many features *new* to the industry.

CONTACTORS
have high rupturing capacity, unusually long life, and are rapid in operation.

PNEUMATIC TIMERS
provide wide range, time limit acceleration unaffected by usual fluctuations in temperature, voltage, and other conditions of application.

CONTROL RELAYS,
heavy duty type, perform undervoltage, interlocking, sequencing, and shunt field control functions.

MILL TYPE OVERLOAD RELAY
combines inverse time thermal Overload protection with instantaneous trip Over-Torque protection in a single device.

DOUBLE DOOR ENCLOSURES
of heavy gauge steel are available in NEMA Types 1, 1A or 5. Doors have vault-type handles. Retained screws on removable back plates save time and eliminate possibility of lost screws.

Write for information on 7950 series Heavy Duty D.C. Control for Steel Mill auxiliaries and Class 9003 Type AD Master Switches. Square D Company, 4041 N. Richards Street, Milwaukee 12, Wisconsin.

for MILL AUXILIARIES

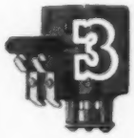
REMEMBER THESE
SQUARE D CONSTRUCTION FEATURES

CONTACTORS

with eight hour rating of 100, 150, 300, and 600 amperes and mill ratings 133% of those values, have low-inertia moving parts, knife-edge bearings, heavy copper contacts, strong blowout, protective arcing horns, and large arc barrier. Spring closed contactors similar in construction are available for dynamic braking.

CONTROL RELAYS

with mechanical construction features duplicating those of the larger contactors have 15 ampere silver contacts, blowout coils and are available in a variety of circuit combinations. Field and plugging relays are of similar design.



PNEUMATIC TIMERS

provide time limit acceleration by transfer of air from one chamber to another through a regulated orifice. Wide range adjustment is unaffected by ambient temperature, voltage, or other conditions of application. Timers may be coupled to contactors or actuated by separate magnet.

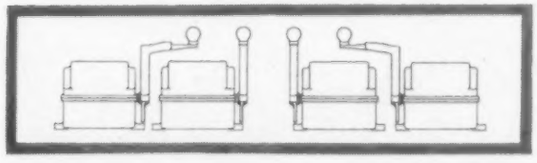
MILL TYPE OVERLOAD RELAY

has visual adjustment for instantaneous trip setting of 200 to 500% rated current. Bimetal heater elements are interchangeable to match motor rating. Heavy duty, double break silver contacts have protective cover. Standard circuit arrangements permit *automatic or remote hand reset.*

New Master Switch with *New* Features!

New Master Switch with straight or offset handle has unusually long travel from OFF to first point in either direction; needle bearings; hardened parts; heavy duty, cam-operated double break silver contacts; and unusually wide electrical clearances. Dust-tight enclosure is split at bearing line for easy maintenance.

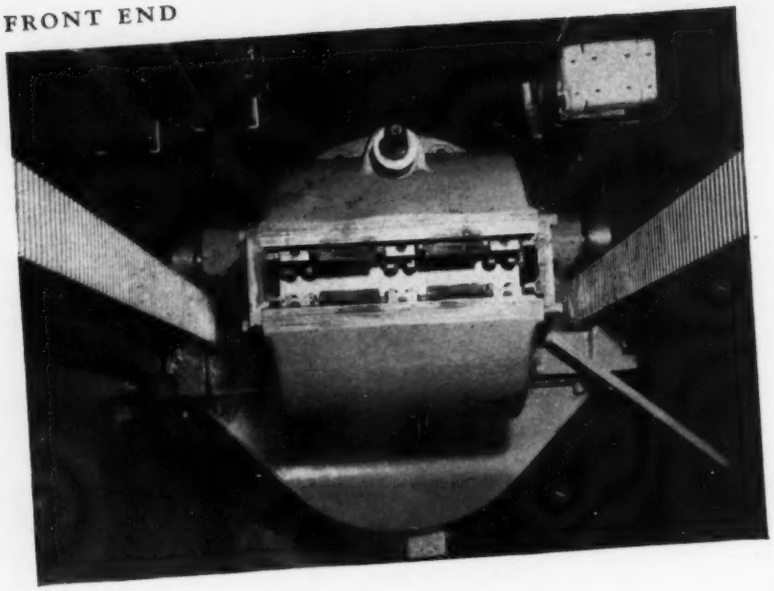
Below — notice how combination of straight and offset handles permits group mounting of 3 or 4 units for convenient operation.



SQUARE D COMPANY

DETROIT • MILWAUKEE • LOS ANGELES

FRONT END



100% SKF-EQUIPPED DRAWBENCH

Thirty-four SKF Ball Bearings are located on drive and track wheels of this rack-type Drawbench built by Aetna-Standard Engineering Co. Each has excellent load capacity because balls and raceways closely conform. And each is sealed, without width increase, against dirt and lubricant leakage. They require no adjustments, and will show no wear. For smooth performance year after year, let SKF supply the right bearing for the right place. 6034

SKF INDUSTRIES, INC., PHILADELPHIA 34, PA.

● *Built by Aetna-Standard Engineering Co., this 3000 lb. Drawbench was developed for drawing non-ferrous tubing. It can be modified for drawing all ferrous and non-ferrous tubes and bars.*

Mr. Manufacturer:

Don't turn down orders for lack of plant capacity.

Let UNITED be your sub-contractor for the manufacture, to exact specifications, of your heavy industrial machinery and equipment. Why not make use of the available production facilities of our six great plants?

All inquiries will be treated confidentially.

UNITED ENGINEERING AND FOUNDRY COMPANY

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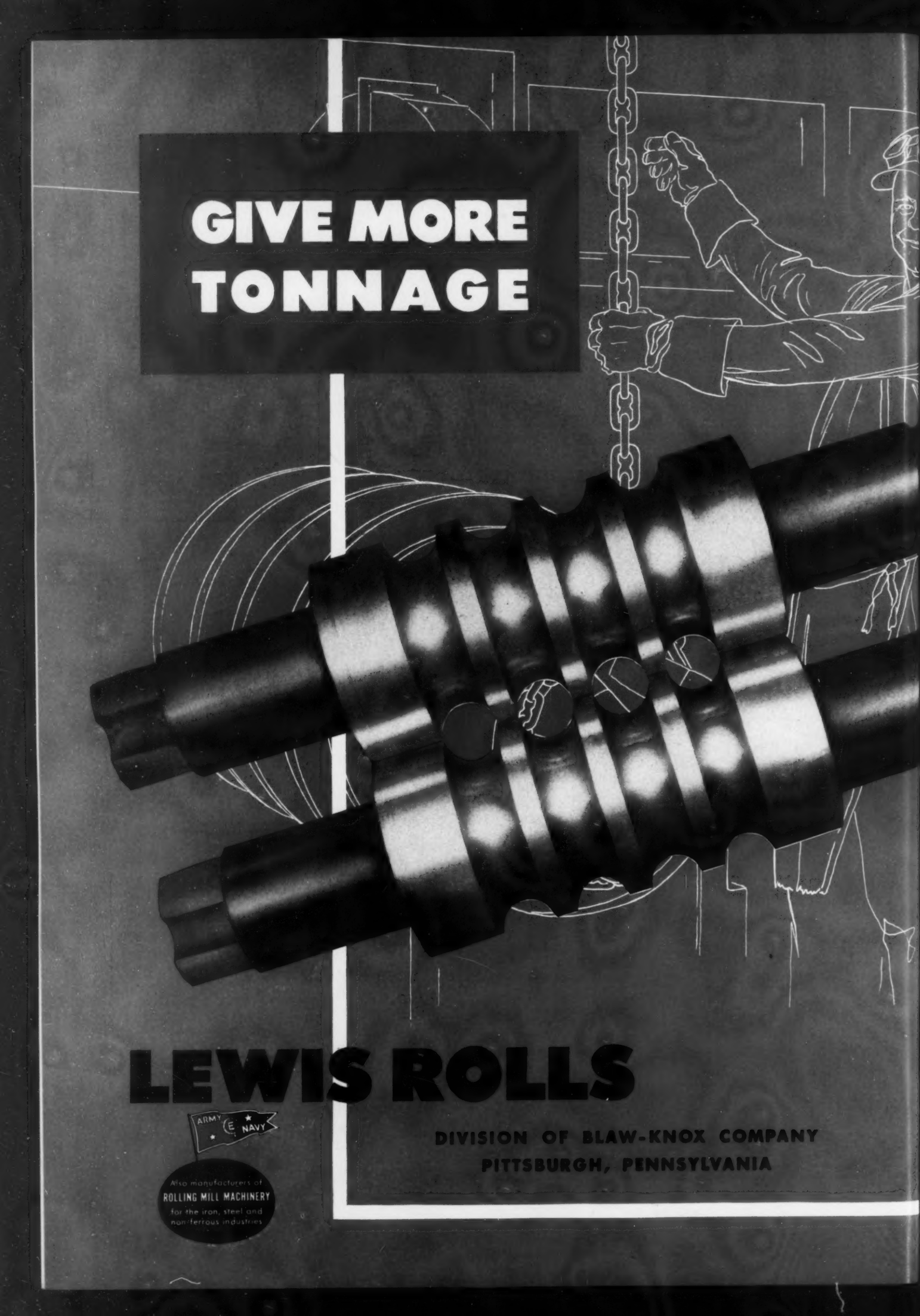
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DIVISION OF BLAW-KNOX COMPANY
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How we can help *you*

meet the greatest challenge

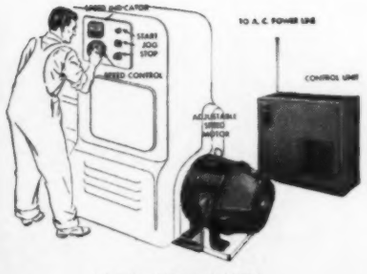
industry has ever faced

WAGES go up and up, along with other costs. Prices lag behind. Some relief may come from outside sources but, primarily, the problem of pushing production *up* and holding costs *down* must be solved by each individual company for itself. Here lies the greatest challenge industry has ever faced.

One sound answer is increased production through the use of more efficient machinery and methods. And this is where we feel confident we can help you. *We have yet to find the industry where Reliance V★S Drive cannot improve the quantity and quality of output, while lowering costs.*

A Reliance Application Engineer will survey your operations, then show you where and how you can benefit most through use of V★S—*the All-electric, Adjustable-speed Drive, operating from A-c. Circuits.* Just phone the nearest Reliance office or write us direct for Bulletin 311.

RELIANCE ELECTRIC & ENGINEERING CO.
1084 IVANHOE ROAD • CLEVELAND 10, OHIO
Branch Offices in Principal Cities



ROTATING SYSTEM
(1 to 200 hp.)

RELIANCE V★S DRIVE

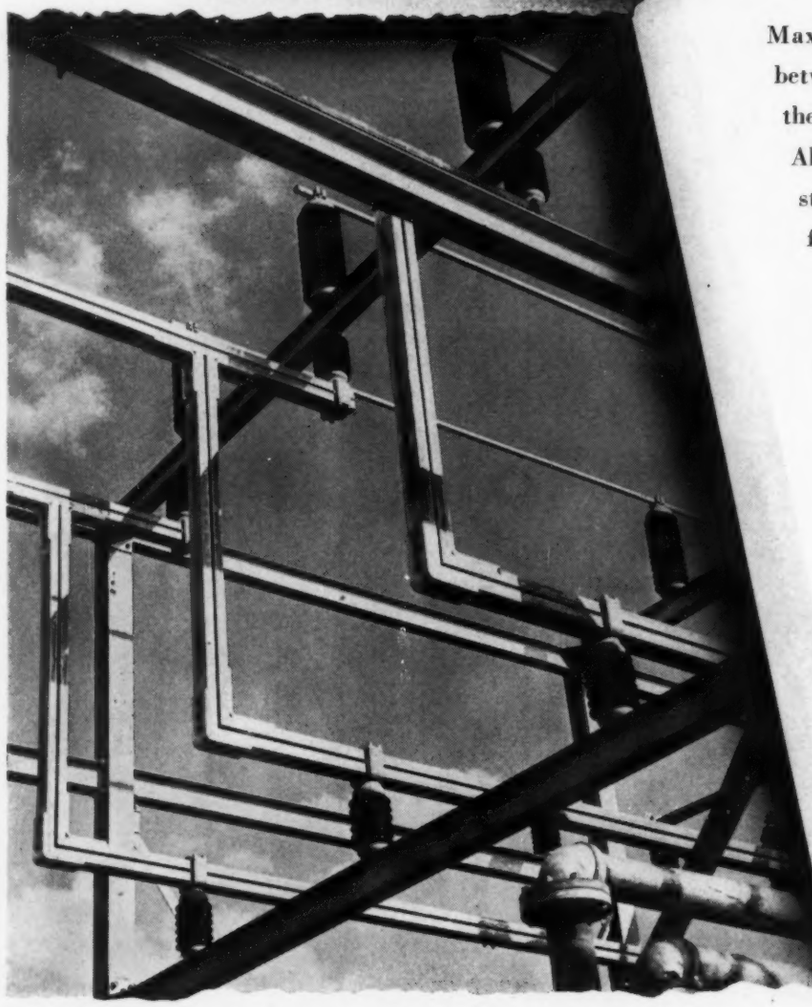
Reliance V★S Drive provides unlimited flexibility of machine operation. Starting, stopping, speed changing, reversing, maintenance of proper tension and other controls are exercised automatically or manually from nearby or remote stations.

ELECTRONIC SYSTEM
(1 to 5 hp.)

RELIANCE A-C D-C MOTORS

"MOTOR DRIVE IS MORE THAN POWER"

For greater resistance to short-circuit stresses, they placed the Alcoa Aluminum channels like this...



Maximum resistance to magnetic forces between phases is obtained here through the horizontal arrangement of the Alcoa Aluminum channels. The box-girder construction makes the buses rigid and, therefore, self-supporting on long spans.

Alcoa Aluminum channels, angles, flats and tubes make good-looking, efficient bus installations. High in electrical conductivity, low in weight, able to resist the elements, first costs are reasonable, upkeep low.

For quotations on Alcoa Aluminum for bus bars, fittings, housing materials and structural shapes, get in touch with the near-by Alcoa sales office. Or write ALUMINUM COMPANY OF AMERICA, 2128 Gulf Bldg., Pittsburgh 19, Pa.

ALCOA ALUMINUM

ALCOA ALUMINUM

"The Mill Operator Who Threw Caution to the Winds."

THERE once was a steel mill operator who was very particular about "safety margins." While he knew that he was losing valuable production time in reversing his huge blooming mill, he really believed that careful practice required long operating cycles.

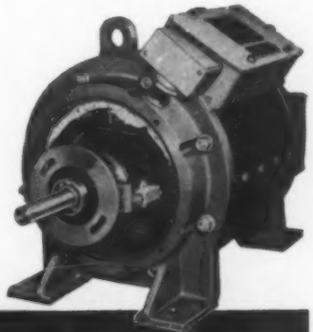
Then came the light. Our operator found out about "Regulex" — the sensitive control which is so fast-acting that it permits reduction of blooming mill reversing time by as much as 40%, yet never allows motor current to exceed safe limits!

Today, that steel man is making every second of blooming mill operation pay its way in mill output. And by eliminating time-wasteful safety margins, he has furthered his reputation for being a "shrewd operator."

MORAL: Maybe "Regulex" control can handle *your* problem of bossing around motors and generators . . . safeguarding their operation, and yet allowing maximum performance.

If the problem involves the control of tension, torque, speed, current —any electrically measurable quantity— "Regulex" control can do the job accurately and quickly. "Regulex" control systems involve no contactors, no trick circuits. The machines themselves are simple and rugged.

For the full story on "Regulex" control, see our nearby sales office, or write ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN. A 2027



ALLIS AC CHALMERS **REGULEX CONTROL** *"The Educated Generator"*

THE CASE OF THE MISSING

Blast Furnace

Where is it?

Shut down for tuyere and bosh plate replacement.

Keep your stacks going full blast, especially today when every ton counts—hold shutdowns to a minimum—with heat-defying N-B-M Blast Furnace Copper Castings. Our new alloying and pouring techniques assure maximum life for your most troublesome burn-out points.

N•B•M

BRONZE AND COPPER CASTINGS

Blast Furnace Copper Castings • Roll Neck Bearings • Slippers • Housing Nuts • Machinery Castings • Babbitt Metals • Acid Resisting Castings Phosphorized Copper

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LOOK TO THE FUSE LEADER FOR PRODUCTION PROGRESS

WARE HI-LAG *Renewable* FUSES

HI-LAG LINK DESIGN—*Important!*

One piece thickness of renewal link, produces strong lag characteristics.

The WARE HI-LAG Renewable Links are designed to provide longer time lag for handling starting, as well as other temporary harmless overloads. Always assuring 100% Protection.

Note exclusive design of WARE HI-LAG Links: the square ends which increase contact areas and maintain low resistance without overheating; the wide metal areas in body, which absorb excessive heat from motor starting current and short heavy surges; the narrow cross members, which allow for expansion without sharp bending; the fusing points, which open with a minimum of arcing on short circuits.

No fuse is more dependable than its link. The WARE HI-LAG Renewable Link of one piece and uniform thickness, insures dependable absorption of heat for time lag. Other exclusive features include the Spring Tension Locking of Links into Circuit—Double Bridge Knife-Blade Assembly—Gas Vents and Simplified Construction, only 3 Parts.

Investigate today! Start economizing with the World's Best and Coolest Operating Fuse.

Write for Brochure giving details of all the COOL FACTS, sizes and prices.

HI-LAG FERRULE FUSE CONSTRUCTION

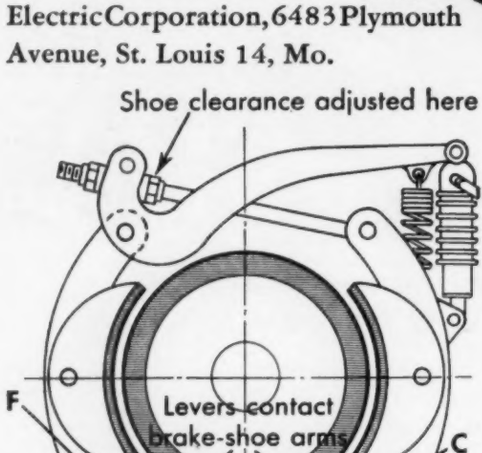
Our ferrule type fuse has a heavy brass bar, which locks into open end ferrule, bridging fuse case. This bridge locks link to prevent twisting and cap tightens on new center contact. No sagging washers or twisted links to cause overheating.

WARE Brothers 4450 W. LAKE ST.·· CHICAGO 24, ILL.

Wagner Self-Centering Device PREVENTS BRAKE-SHOE DRAG

The new self-centering device on Wagner hydraulic bridge brakes prevents brake-shoe drag—thereby eliminating unequal brake-shoe wear and undue heating of the brake wheel.

It is simple in operation and requires no readjustments after installation. With the Wagner self-centering device, brake shoes remain centered irrespective of lining wear. It prolongs the life of the brake lining and reduces maintenance expense. Write for complete information. Wagner Electric Corporation, 6483 Plymouth Avenue, St. Louis 14, Mo.



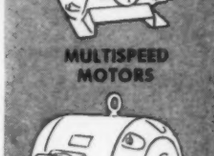
Here's how it works: The Wagner self-centering device utilizes the principle of the swinging door—in which a spring returns the door to the same starting point irrespective of direction of swing. A leaf-type spring (A) in the base of the brake actuates the ends of two levers (B and C) which bear equally against the two brake-shoe arms (D and E). The spring assures equal movement of both shoe cams, thus preventing either brake shoe from remaining in contact with the brake wheel. Brake shoes are originally centered at point (F) by means of a setscrew which is locked after the shoes have been accurately centered—after which the self-centering device keeps the shoes centered and prevents brake-shoe drag until relining is necessary, at which time recentering by means of the setscrew may be necessary.

SQUIRREL-CASE MOTORS

TOTALLY-ENCLOSED FAN-COOLED MOTORS

WOUND-ROTOR MOTORS

MULTISPEED MOTORS


EXPLOSION-PROOF MOTORS

SPLASH-PROOF MOTORS

POWER AND DISTRIBUTION TRANSFORMERS

UNIT SUBSTATIONS

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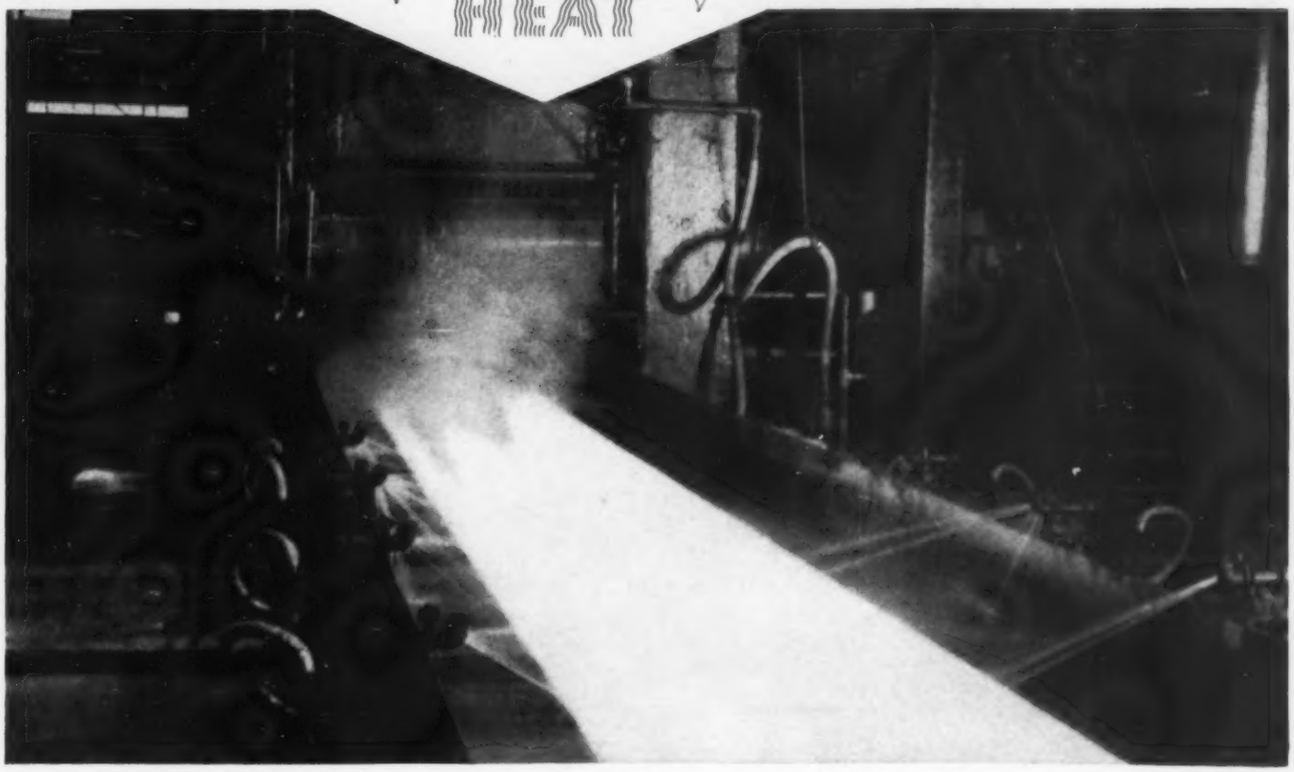
built to BEAT THE HEAT and like it



DELTABESTON* POWER CABLE

From blast furnace to run-out tables, steel mills call for a *temperature-conscious* choice of cable. And with DELTABESTON cables to choose from, every combination of conditions involving heat, high moisture, and corrosive vapors can be met "on the nose."

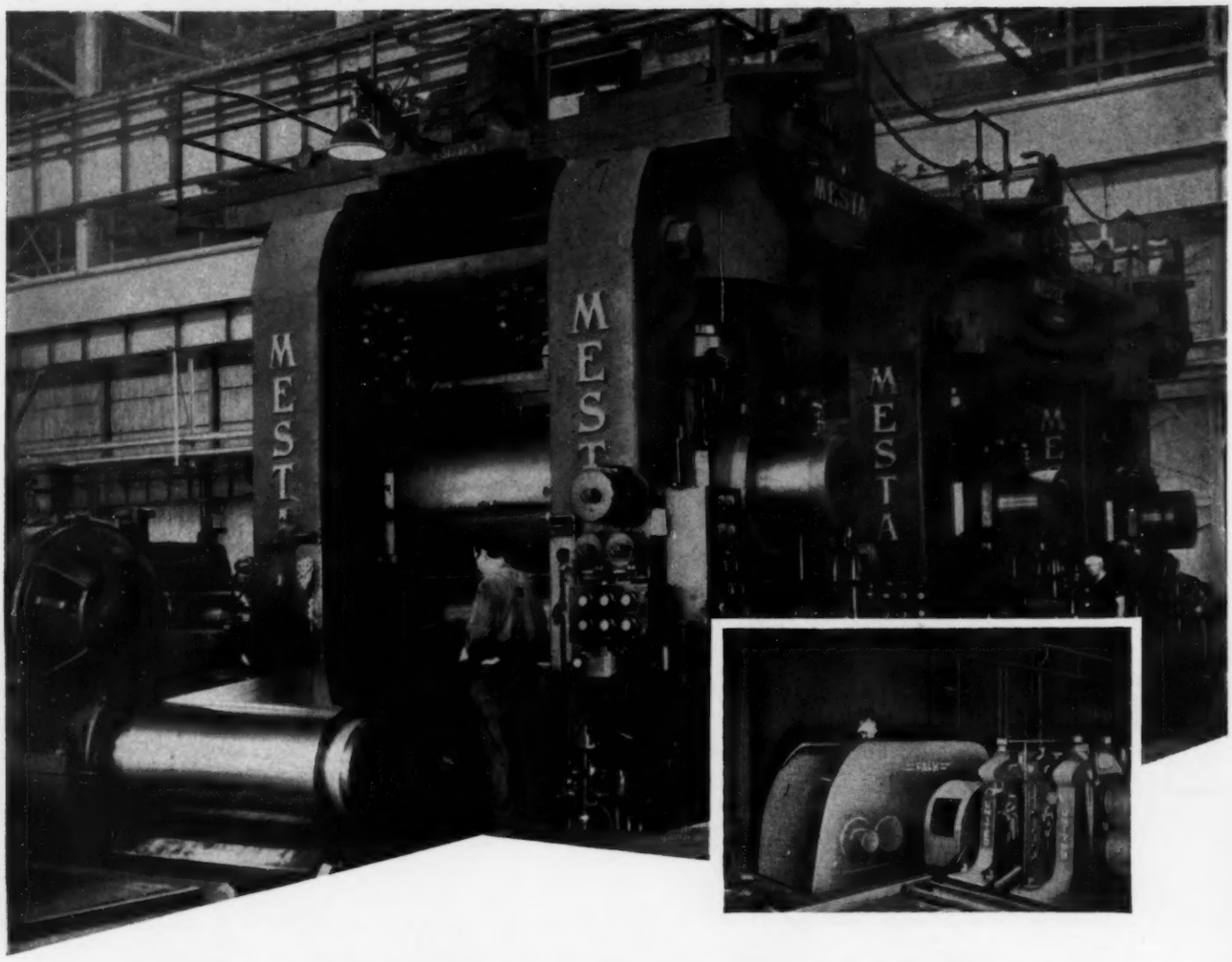
There's a DELTABESTON cable for spots where high ambient temperatures are continuous, such as around furnaces, kilns, and soaking pits. Other types of Deltabeston give protection against emergency temperature rises. They offer low-cost assurance against shutdowns, fires, and frequent replacement. If you wish, the assistance of experienced cable specialists is available to help you choose the right cable for any job.

Deltabeston power cables, Types AVA and AVL, are recommended for locations where temperatures stay high. Can be installed exposed or in conduit. Maximum copper temperature 110 C (230 F).

For the full story on DELTABESTON types, sizes, and performance, write to Section Y-562-31, Appliance and Merchandise Department, General Electric Company, Bridgeport, Conn. All Deltabeston wires and cables are distributed nationally by G-E Merchandise Distributors.

*Trade-mark Reg. U. S. Pat. Off.

GENERAL ELECTRIC



GIVE HEAVY-DUTY GEAR DRIVES

Heavy-Duty Protection

ESPECIALLY made to give long-lasting protection to gears and bearings of heavy-duty reduction drives, *Texaco Meropa Lubricants* have a load-carrying capacity more than ample to protect any gear.

Texaco Meropa Lubricants have demonstrated in service a very high oxidation stability and an outstanding resistance to thickening. They do not separate in use or in storage, and are non-corrosive.

There is a complete line of *Meropa Lubricants* to meet the requirements of every type of gear drive. Operators also use them with excellent results on coiler, edger roll, slab shear and run-out drives, table manipulator gears, and many other places.

For Texaco Products and Lubrication Engineering Service, call the nearest of the more than 2300 Texaco distributing plants in the 48 States, or write:

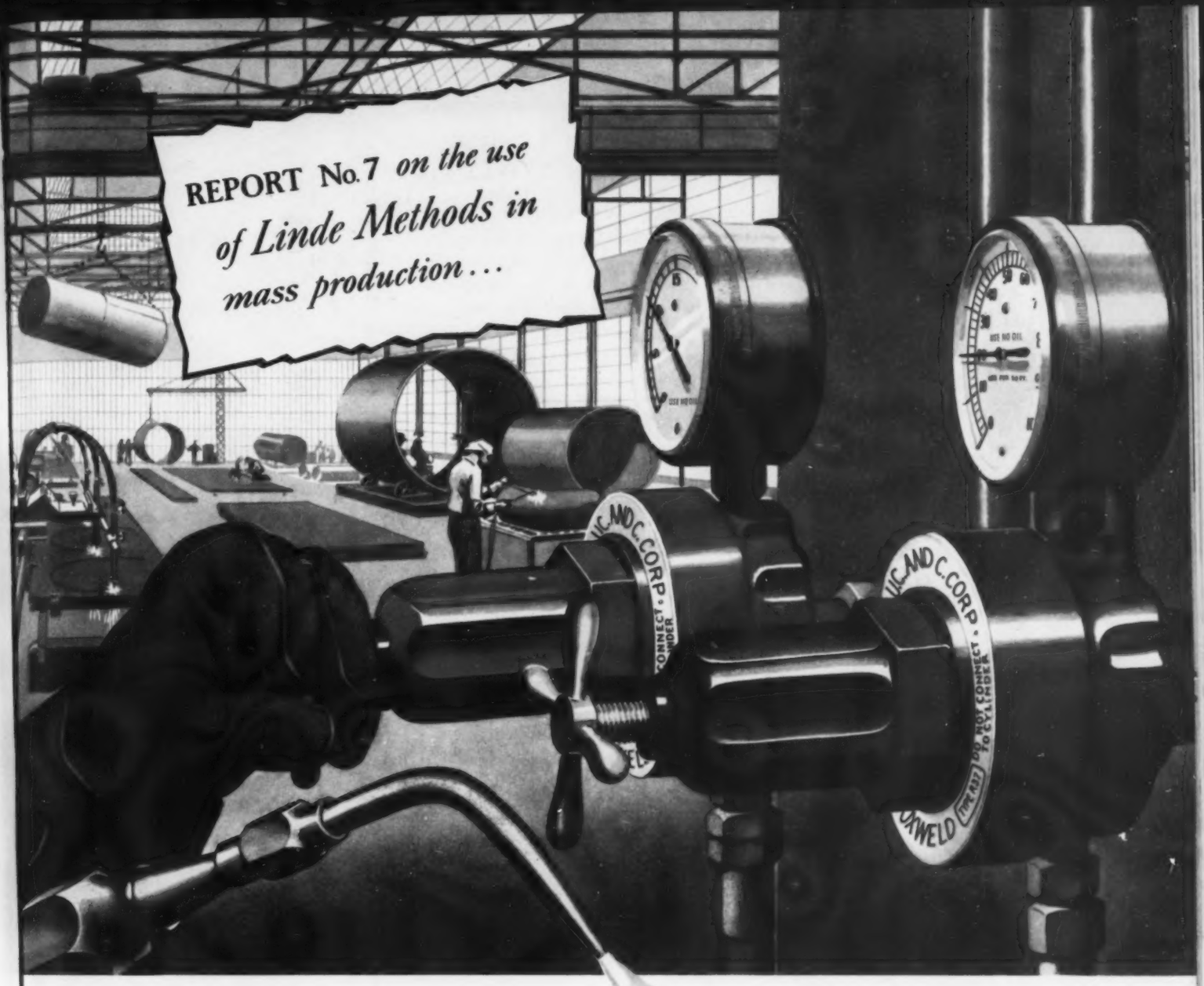
The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Meropa Lubricants

FOR STEEL MILL REDUCTION GEARS

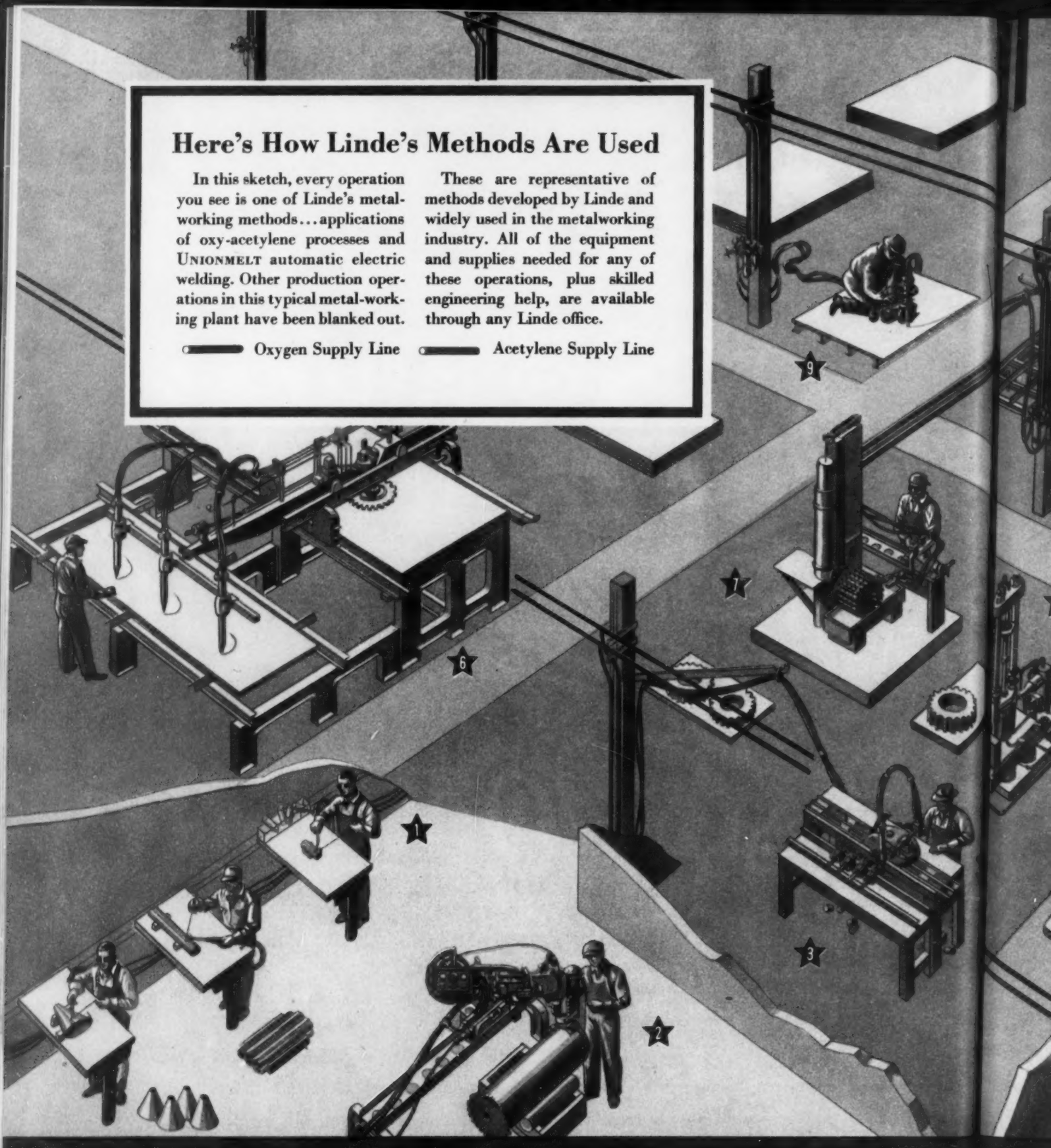
TUNE IN THE TEXACO STAR THEATRE EVERY SUNDAY NIGHT STARRING JAMES MELTON WITH HIS GUEST, ED WYNN—CBS



In METAL-WORKING PLANTS LINDE METHODS are Important in Many Steps of Manufacture

A continuous succession of Linde developments for oxy-acetylene flame-joining, cutting, forming, and treating metals has changed fabrication methods so much that in many metalworking plants oxygen and acetylene are now made as readily available as water and electric power. Equipment can be connected to the supply line anywhere by means of convenient outlets, such as you see above.

In the sketch that you will see as you turn this page, are shown some of the many uses of the intensely hot oxy-acetylene flame in the production line. One of these—marked 8—is a relatively new one.



Here's How Linde's Methods Are Used

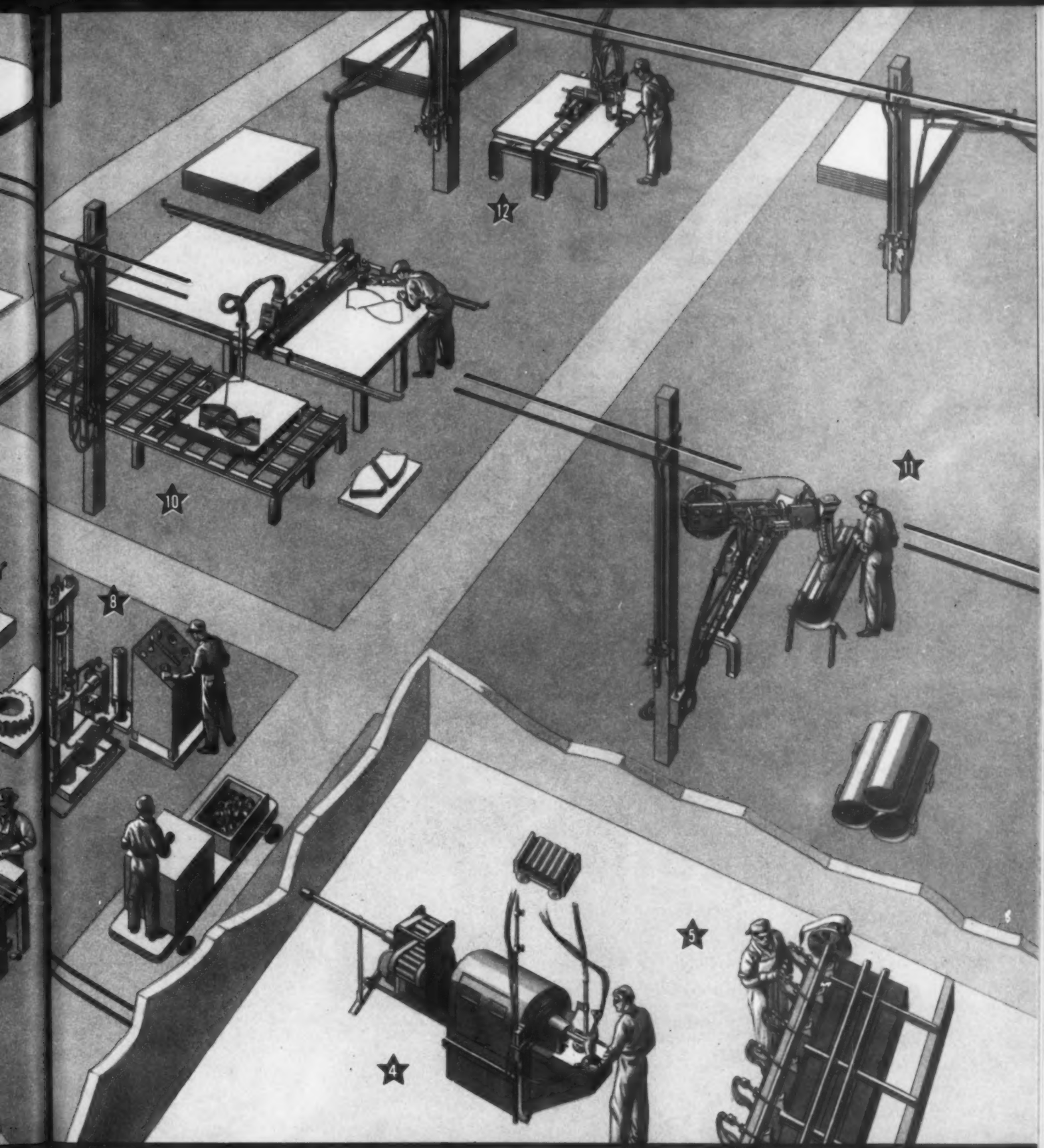
In this sketch, every operation you see is one of Linde's metal-working methods... applications of oxy-acetylene processes and UNIONMELT automatic electric welding. Other production operations in this typical metal-working plant have been blanked out.

These are representative of methods developed by Linde and widely used in the metalworking industry. All of the equipment and supplies needed for any of these operations, plus skilled engineering help, are available through any Linde office.

Oxygen Supply Line Acetylene Supply Line

Methods developed by THE LINDE AIR PRODUCTS COMPANY

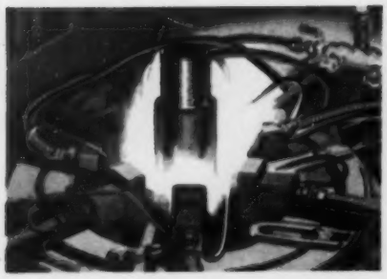
1. Manual welding of small assemblies.
2. UNIONMELT welding of sprockets to drum ends.
3. Flame-cutting risers from cast gear blanks.
4. Flame-spinning of tubing to form end closures.
5. Flame-cutting tubing ready for spinning.
6. Shape-cutting three sprockets simultaneously.



Simplify the Production of Metal Products of Many Kinds

1. Flame-hardening to lengthen sprocket life.
8. Pressure-welding bearing sections to shaft.
9. Cutting drum heads with a portable flame machine.
10. Flame-cutting parts from stacked plate.
11. Welding the seam by the UNIONMELT electric process.
12. Flame-planing plate edges to be welded.

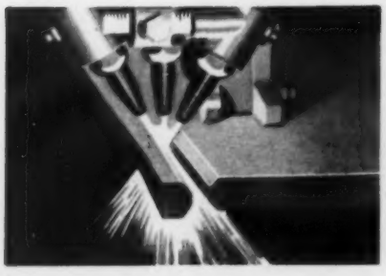
WHAT LINDE FLAME METHODS WILL DO



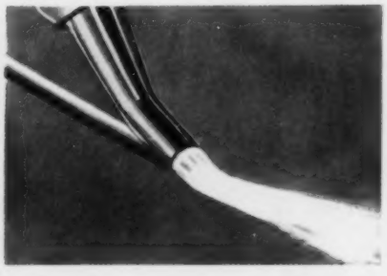
A hard, wear-resistant case can be given to local surfaces of hardenable steel by oxy-acetylene flames followed by a water quench. Chemical composition of the metal and toughness of the core are not affected.

End-forming of tubular products, for completely or partially closing the ends, or for reducing diameters at any point, can be done without interruption by applying oxy-acetylene flames to rapidly spinning tubes.

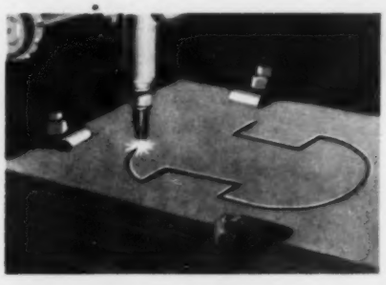
Smooth - sweep bends in pipe of almost any diameter and at any angle can be made without thinning the pipe walls or impeding flow, by applying the intense, fully controlled heat of oxy-acetylene flames.



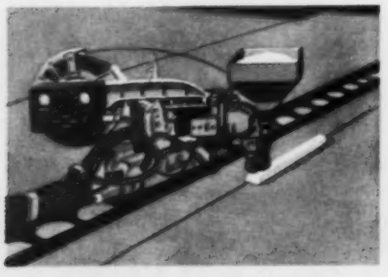
Preparing plate edges with flame-cutting equipment speeds trimming and beveling of plate preparatory to welded fabrication. Cuts in several planes can be made simultaneously, accurately, and at low cost and power consumption.



Grooving of metal surfaces, the preparation of plate edges for welded fabrication, the removal of temporary welds, and the preparation of cracks in castings for repair by welding are done easily with oxy-acetylene flame-gouging.



Parts of any size, shape, or thickness can be fashioned from stock steel plate quickly and accurately with flame-cutting machines. Flame-cut edges are smooth...frequently require no machining.



Automatic electric welding by the UNIONMELT process makes high-quality welds in steel of any thickness at speeds up to 20 times faster than other methods of welding with rods.

Oxy-acetylene flames remove scale, rust, grease, corrosive salts, and moisture from surfaces of steel prior to painting. Paint goes on faster, bonds tighter, lasts longer.

Pressure plus heat from oxy-acetylene flames applied simultaneously, quickly joins plate, pipe, shafting, railroad rails, and metal sections of the same or different metallurgical characteristics.

THE LINDE AIR PRODUCTS COMPANY

Unit of Union Carbide and Carbon Corporation

30 E. 42nd St., New York 17, N. Y. UCC **Offices in Other Principal Cities**

In Canada: Dominion Oxygen Company, Limited, Toronto

The words "Linde" and "Unionmelt" are trade-marks of Union Carbide and Carbon Corporation or its units.

Other reports on the use of Linde methods in SHIPBUILDING, in STEELMAKING, METAL-FABRICATING, PIPE, PRODUCTION AND FABRICATION OF STEEL, and UNIONMELT WELDING will be sent on request.

Continental

designers and builders of Dependable

Plate Mill Equipment

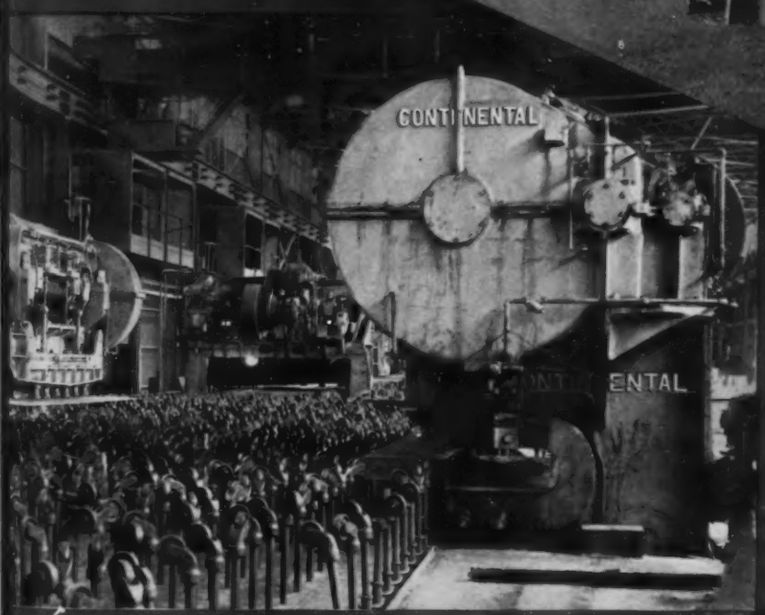


Plate Mill Finishing Equipment, 114" x 150" Roll Cutting and Slitting Shears and Coiler Reel

Continental-built" is an important phrase to every ...rous and non-ferrous metal producer. It means ad-...nced engineering and intimate experience with the diffi-...l problems in designing and building dependable, *...fit-producing* equipment. Continental is ready *now* ...elp you on *any* equipment problem.

Continental

Continental

FOUNDRY & MACHINE CO.

PITTSBURGH • CHICAGO

Plants at East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.

All these - and many other types....

Iron Rolls

Steel Rolls

by

Continental

Continental-built for longer roll life—greater tonnage—lower roll costs. Continental rolls are available in many standard or special types to fit the most rugged requirements—from carbon steel, alloy steel, iron and alloy iron chilled rolls for hot or cold, ferrous or non-ferrous rolling mill operations. Your next rolls should be *Continental-built!*

Continental

FOUNDRY & MACHINE CO.

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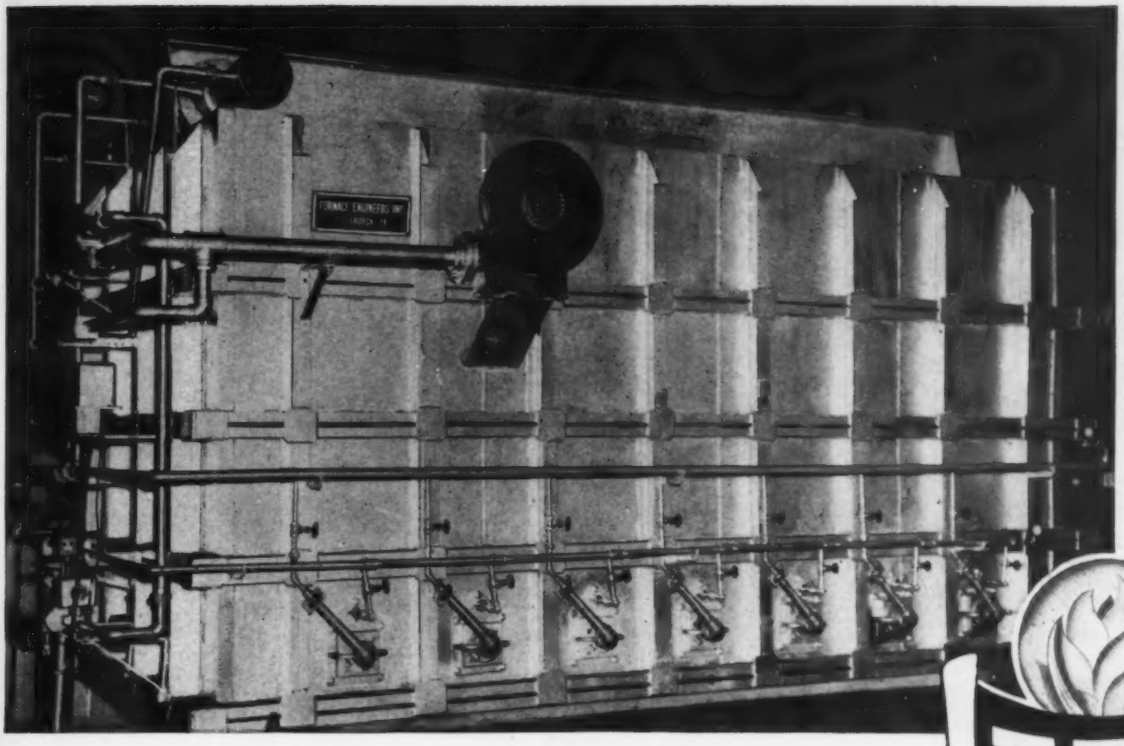
Plants at East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.



F.E.I.

To cost-minded production men, the story of F. E. I. direct-fired Cover Annealing Furnaces is proving of more than ordinary interest. These furnaces are, indeed,

making history in production heating

When you investigate and find out what they have done, and are doing, to step up production per furnace, to improve control, quality and uniformity (practically eliminating "stickers" and rejects in coils and flats)—you'll sing their praises, too. It's a case of shaving not merely nickels and dimes, but dollars, from the cost per ton. Even on fuel cost alone—an item often looked upon as of no importance—savings of fifty cents to a dollar per ton have been made, in comparison with equipment heretofore considered tops in the heating field.

The significant facts about F.E.I. performance records are yours for the asking, as are the services of our engineers in helping you install new, or convert old cover furnaces to obtain greatly lowered heating cost.

★ ★ ★ **F. E. I. EQUIPMENT** ★ ★ ★

Direct Fired Cover Furnaces for Annealing, Spheroidizing, Normalizing and Bright Annealing of wire, rods, coiled strip, flat sheets and tin plate.

Convection Bases especially designed for heavy coil loads, give 200% to 400% longer life.

Galvanizing, Patenting, and ***Normalizing Furnaces*** for WIRE, BAR, and TUBE MILLS.

Galvanizing Furnaces for Pipe, Sheet and Job Plants.

FURNACE ENGINEERS, *Inc.*

Specializing in the design, manufacture and installation of furnaces for the metal working industries

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.

Selection of factory-assembled Limitamp control for this plant made it possible to install a single compact group, instead of a number of separate devices, in a small amount of floor space.

Here's FAST, "PACKAGED" Short-circuit Protection for Your High-voltage Motors... Limitamp Control

LIMITAMP CONTROL

OPERATES WITHIN A SPLIT CYCLE

● You can give your motors sure short-circuit protection by specifying G-E Limitamp control. Faster than any breaker, this "all-in-one-unit" control, with its EJ-2 fuses, clears fault currents in a half cycle.

When a short occurs, the fuses cut off the rise in current in less than a quarter cycle. And the short is cleared long before the current has time to harm the contactors or motor.

GIVE YOUR STEEL PLANT THESE IMPORTANT ADVANTAGES

Completely co-ordinated control—Limitamp is "packaged" in a single unit which is easy to install and attractive in appearance.

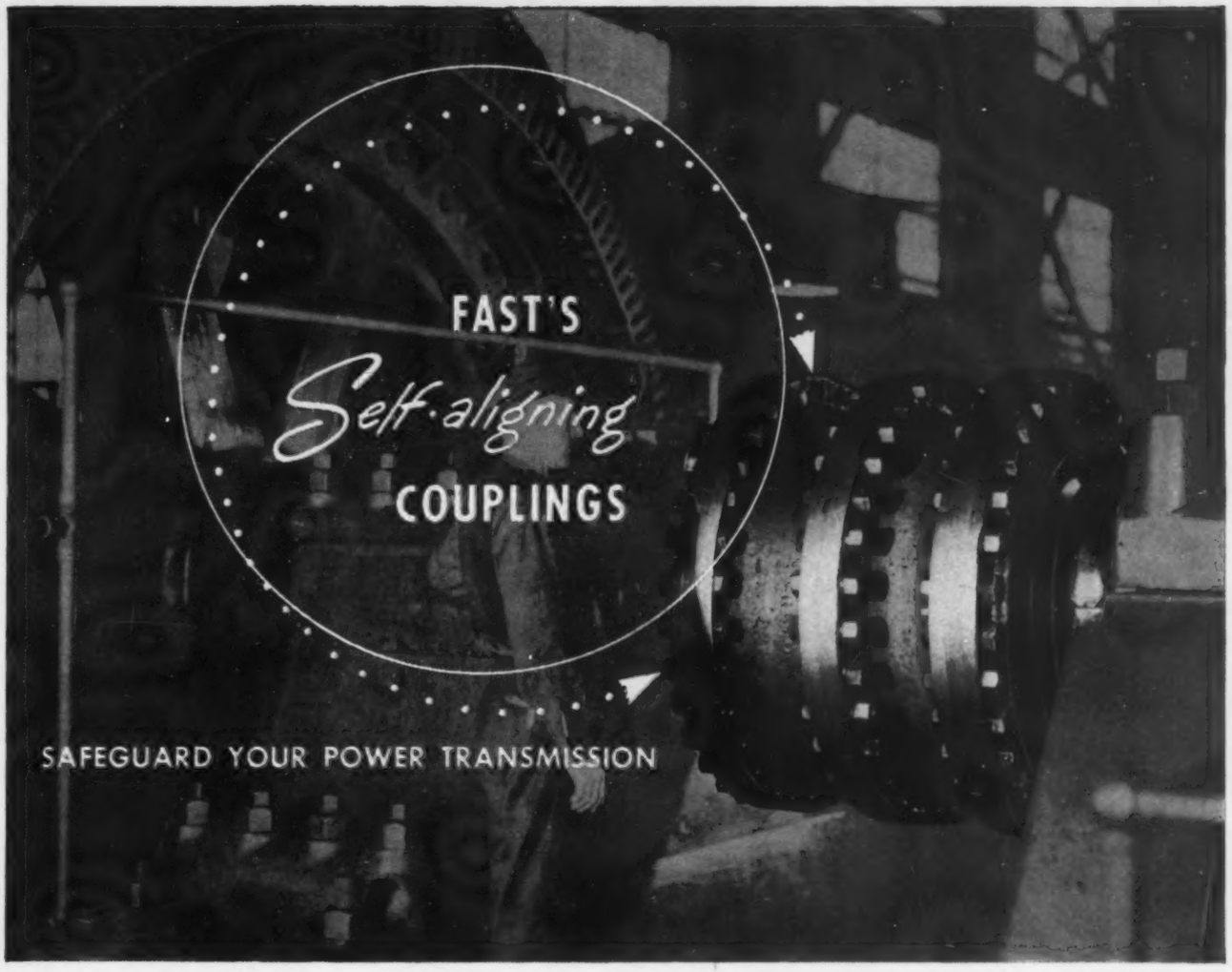
Full protection—If voltage is low or power fails, the motor is taken off the line. And it will not restart on return of power. Accurately calibrated overload relays protect your motors from overheating due to sustained overloads or single-phasing.

Years of service—Air-break contactors, good for millions of operations, meet the most severe requirements of high-voltage motor-control service. Contact-tip life is many times that of comparable oil-immersed tips.

Safety for operators—And because it is totally enclosed in an all-metal case, Limitamp control provides protection for all operating personnel.

GENERAL ELECTRIC

670-167-8900

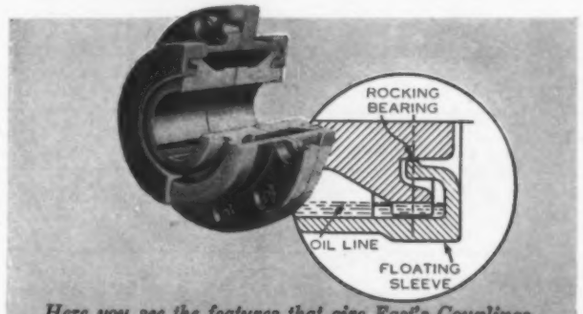


24 years of 20-hours-per-day service with no delays—no expense

Here's a Fast's Coupling that has almost earned its 25-year veteran's button. Transmitting power from a 3000 HP motor to a billet mill in the Midland Works of Crucible Steel Company of America, it has been on the job for 24 years, working an estimated 20 hours a day. According to the Maintenance Engineer, Mr. R. F. Chaffin, this Fast's Coupling has never caused any interruption to service, or required any repairs or replacements. From all indications, it is still as serviceable as the day it was installed.

Several hundred Fast's Couplings are serving in this same plant with equal dependability and satisfaction.

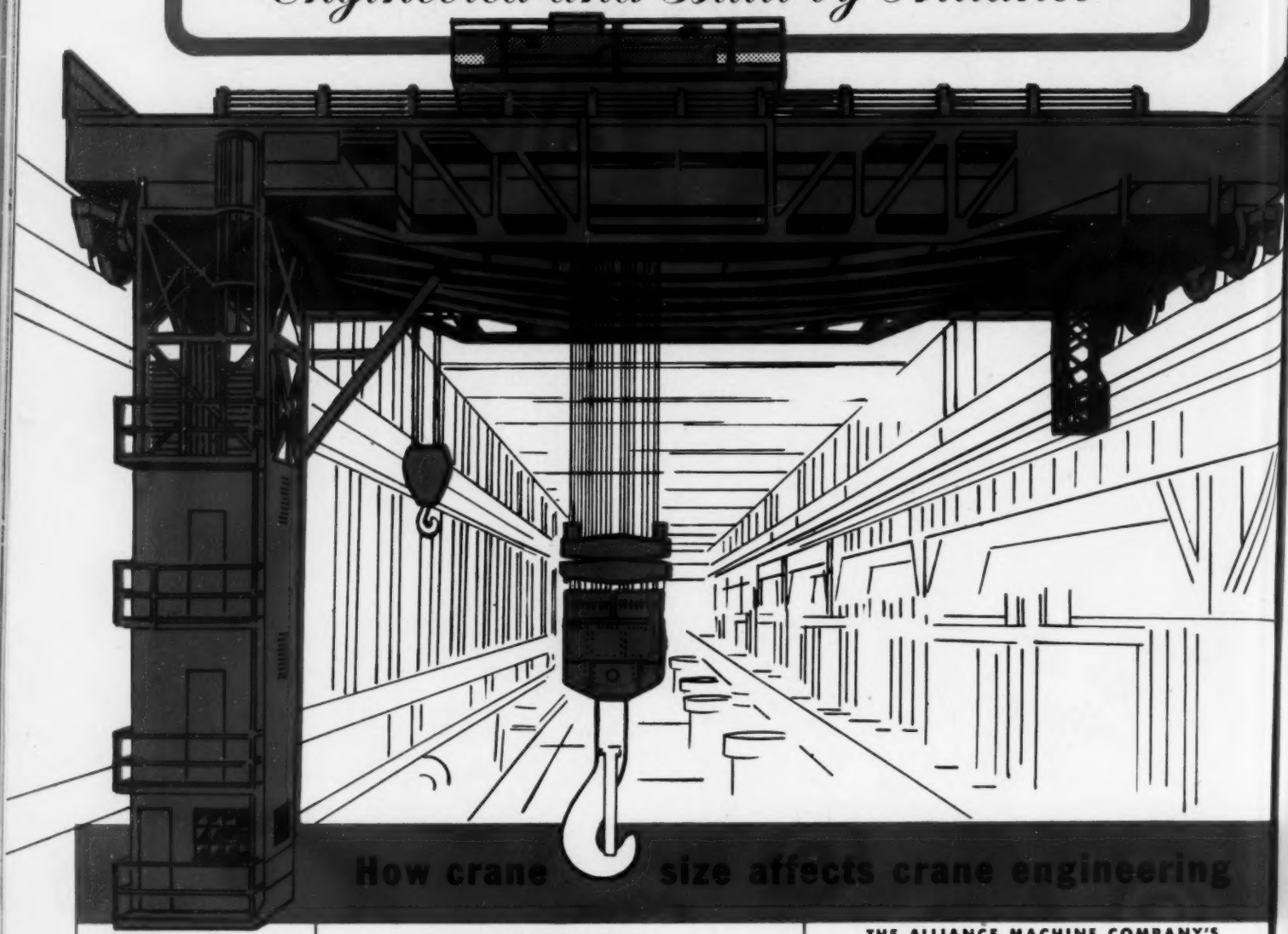
Every engineer knows that there is no substitute for actual performance as a basis for sound specifications. Records of Fast's Couplings certify their durability and dependability, and provide the best possible guide in selection. Ask for a catalog. Bartlett Hayward Division, Koppers Company, Inc., Baltimore 3, Md.



Here you see the features that give Fast's Couplings their remarkable dependability. All parts are protected from wear by a positive film of oil. Oil purity is guarded by rocking bearings, located in the one position where they maintain a positive metal-to-metal seal. There are no perishable parts in "Fast's."

a **KOPPERS** *Product*

World's Largest **Overhead** *Cranes*
Engineered and Built by Alliance



How crane size affects crane engineering

ITEM	REQUIREMENT	THE ALLIANCE MACHINE COMPANY'S RECOMMENDATION
Trolley Frames	Prevention of Bearing misalignment and elimination of bolted bearing brackets and motor bases.	One-piece steel casting or welded trolley.
Girders	Minimum deflection and maximum horizontal stiffness, based on allowable fibre stress.	Parallel flanged girders with ample sections and liberal gusset plates and end bracing.
Ropes	Liberal factor of safety and use of extra flexible wire rope.	Minimum drum and sheave diameters shall be 30 times the diameter of rope. Fleet angle—minimum.
Gearing	Designed to handle overloads encountered in steel mill operation.	Gear teeth designed with high factor of safety and low tooth pressure. All gears enclosed and running in a bath of oil.
Motors	Mill type motors provided, which are equipped with C. S. Frames.	Conservative half hour rating, based on ambient temperature conditions.
Bearings	Smooth operation and long life.	Application of roller bearings with maximum life expectancy and sealed sleeve bronze bearings with low bearing pressure to insure long life.
Maintenance	Easy accessibility.	All working parts within easy reach, and safety platforms provided where necessary.
Operation	Dependability and safety.	Cabs—adequate visibility for operator. Convenient location of controls. Steel footwalks—hand rails. Stairways to cab and top of bridge.

THE ALLIANCE MACHINE COMPANY

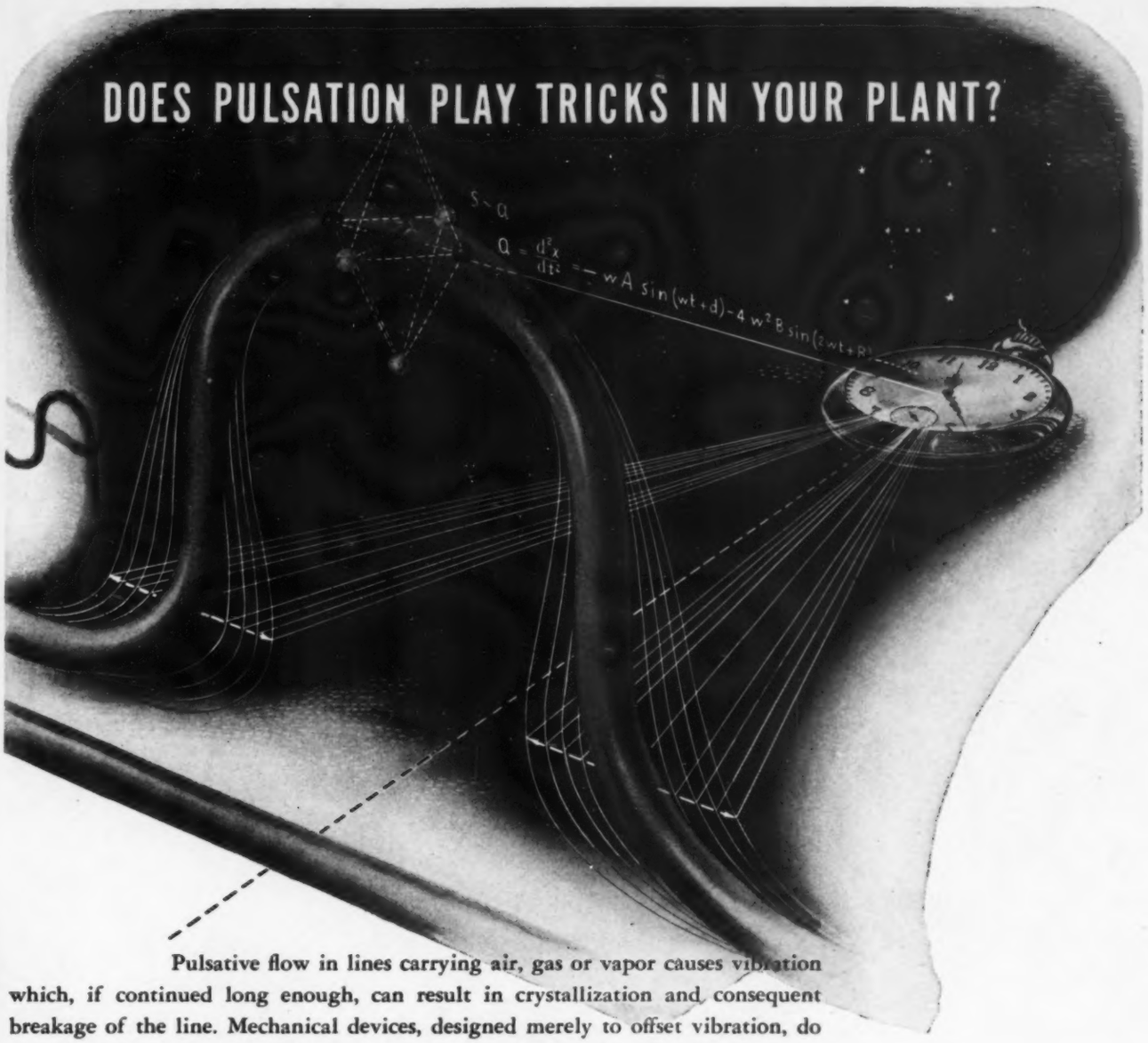
ALLIANCE, OHIO • PITTSBURGH, PA. • 1622 OLIVER BLDG.

★

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES
STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH
CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION

Alliance

DOES PULSATION PLAY TRICKS IN YOUR PLANT?



Pulsative flow in lines carrying air, gas or vapor causes vibration which, if continued long enough, can result in crystallization and consequent breakage of the line. Mechanical devices, designed merely to offset vibration, do not eliminate the pulsative flow within the line which is the constant source of trouble. The FLUOR Pulsation Dampener removes this cause of vibration by changing pulsative flow into a smooth, steady stream.

For example—in a large Southeastern Refinery, serious vibration was set up by pulsative flow in overhead piping from the Compressor Plant to the Catalytic Cracker. Vibration was so severe as to break pipelines, necessarily resulting in shutdown of the equipment. FLUOR Pulsation Dampeners were installed on discharge laterals at all of the compressors, solving the problem by converting pulsative flow into a steady stream.

The FLUOR Pulsation Dampener has no moving parts. It operates with beneficial effects on friction losses, horsepower savings and rate of flow. If vibration plays *tricks* in *your* plant, it may be due to pulsations in air, gas or vapor lines. In that case, the FLUOR Pulsation Dampener is your answer.

FLUOR PULSATION DAMPENER

fc SINCE 1890

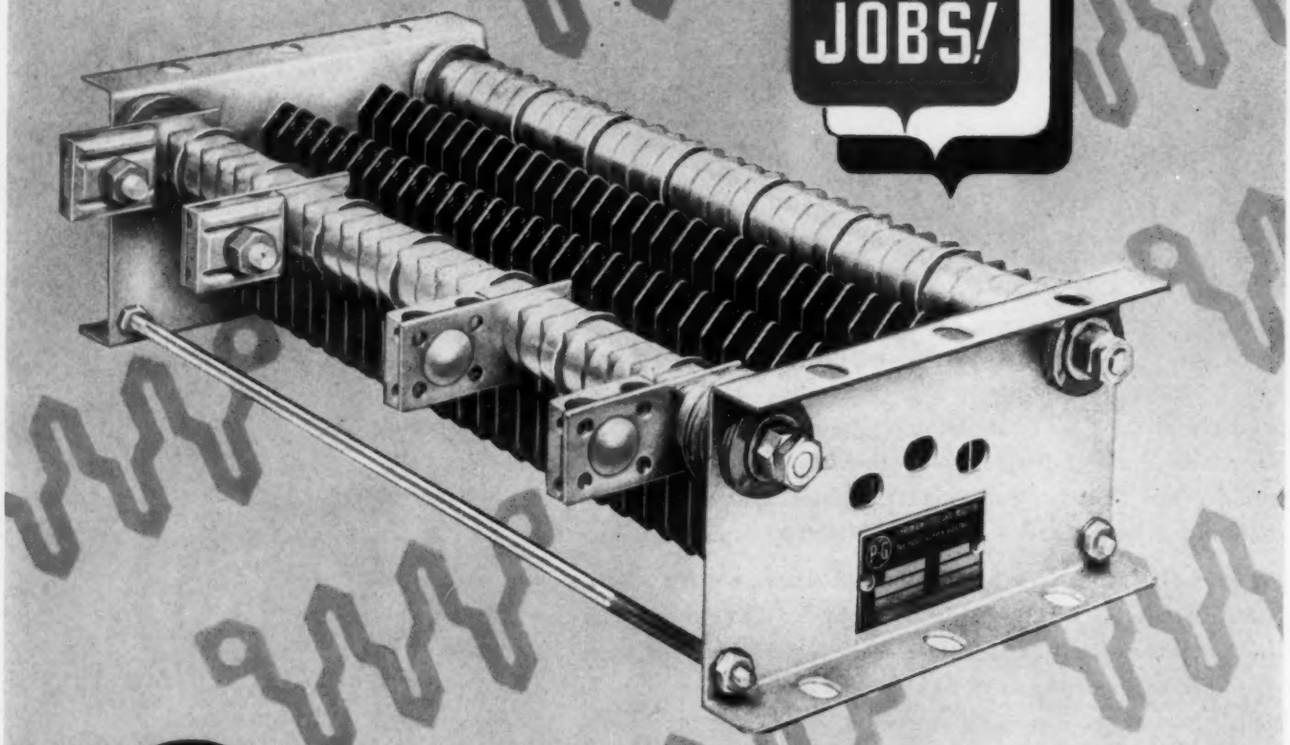
THE FLUOR CORPORATION, LTD. 2500 South Atlantic Boulevard, Los Angeles 22
NEW YORK • PITTSBURGH • KANSAS CITY • HOUSTON • TULSA • BOSTON

ENGINEERS · MANUFACTURERS · CONSTRUCTORS

P-G *Nonbreakable*

STEEL GRID RESISTORS

For THOSE TOUGH JOBS!



The Nonbreakable Steel Grid Resistor

P-G

THE POST-GLOVER ELECTRIC COMPANY

•ESTABLISHED 1892•

221 WEST THIRD STREET, CINCINNATI 2, OHIO

OKOCORD WELDING CABLE

. . . built to stand up under use and abuse

Okocord cables for welding are designed to transmit uninterrupted power under severe conditions and external abuse. In the Okocord single conductor electrode-holder cable shown here, fine copper wires are rope-stranded for greater flexibility. They give longer life because they are first stranded together on the Uni-lay principle and then "lubricated" by Okonite's special treatment. Their increased flexibility results in better welding through easier, less tiring use of the electrode-holder. A paper wrap over the conductor leaves it clean for terminating, increasing flexibility still further. Additional mechanical strength is provided by seine twine cords embedded in an Okoprene sheath while the Okoprene protects against corrosion, resists oil, acids and alkalies.

There are many other types of Okocord portable cords and cable which cover a wide variety of industrial applications. The Okonite Company, Passaic, N. J.

OKOCORD ELECTRODE-HOLDER CABLE

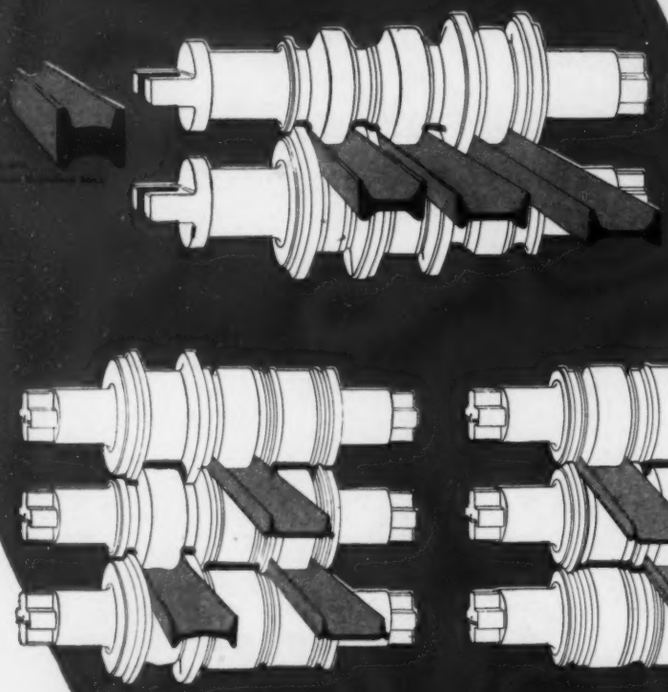
Size A.W.G.	Number of Wires	Carrying Capacity Amperes	Volts drop 60° C. Copper Temp.
4	1078	100	3.18 per 100 ft.
3	1372	150	3.70 " " "
2	1715	200	3.92 " " "
1	2156	250	3.88 " " "
1/0	2695	300	3.72 " " "
2/0	3381	375	3.68 " " "
3/0	4263	450	3.51 " " "
4/0	5341	550	3.41 " " "

OKONITE OKONITE SINCE 1878 **insulated wires and cables**

4471

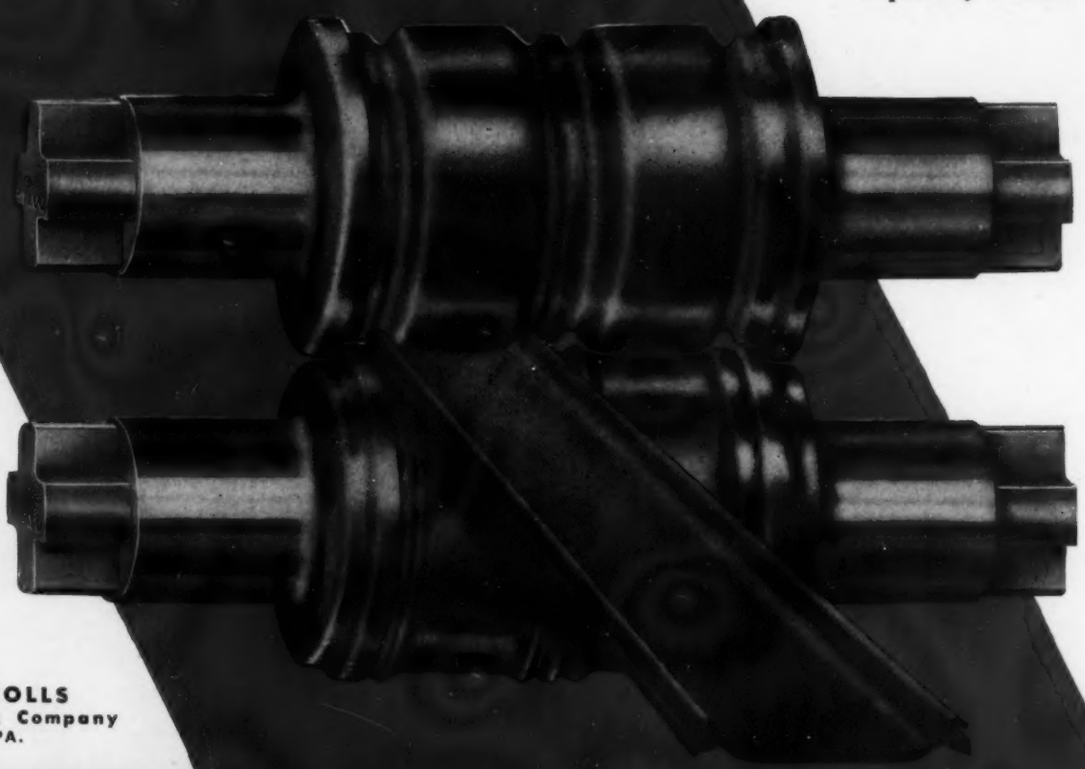
ROLLING TECHNIQUE . . .

Piling Bar



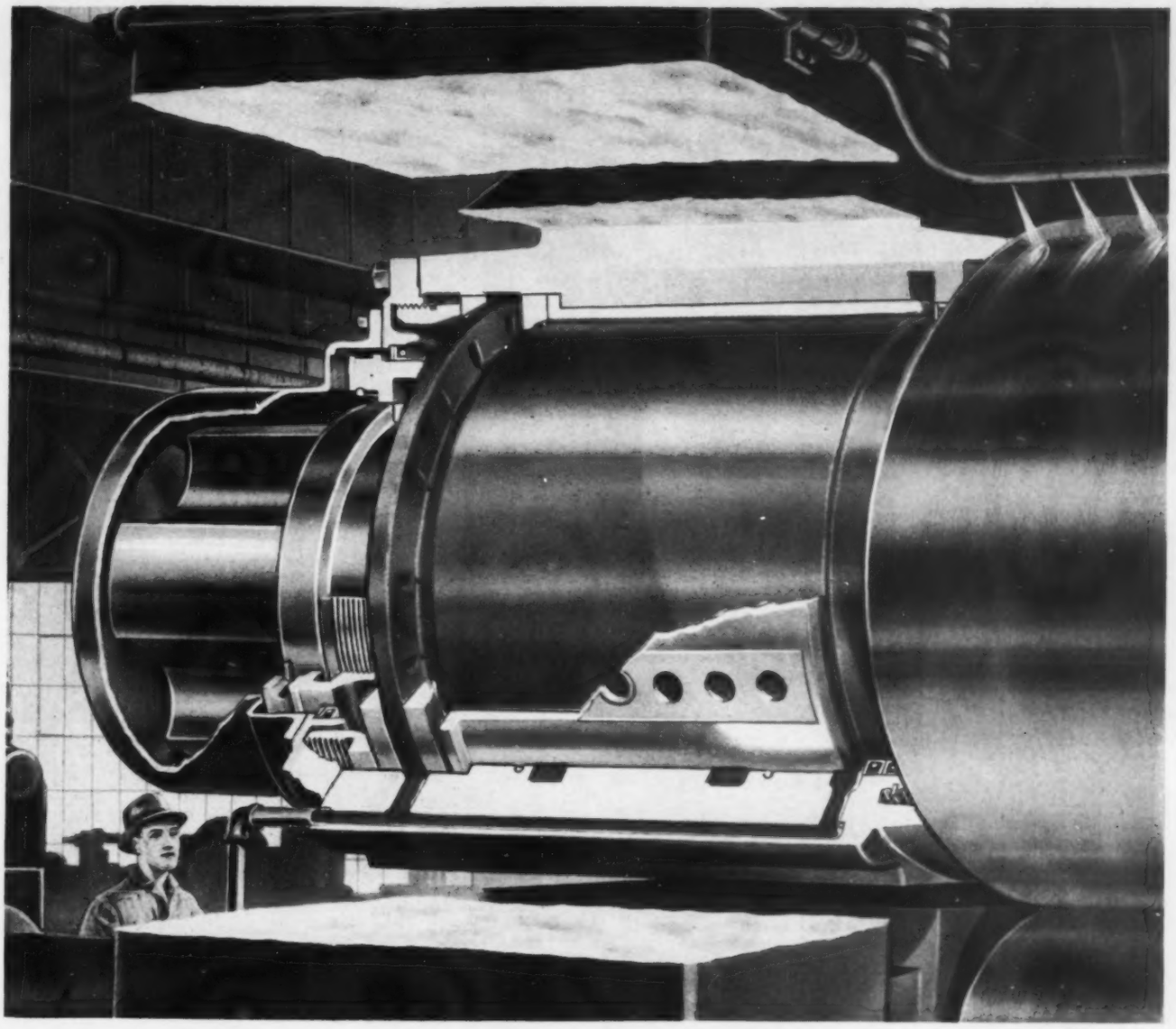
Piling Bar is rolled both in the arched type and Z type in addition to the flat bar shown, but regardless of the section, they are all considered difficult to roll and present many problems in rolling. Pittsburgh Rolls aid materially in solving these problems, thereby producing high tonnages of quality bar.

Pittsburgh rolls are made by skilled craftsmen whose thorough practical knowledge of metallurgy, foundry methods and accuracy in roll turning is the accumulated result of more than seventy-five years devoted to the exclusive manufacture of rolling mill rolls. The use of Pittsburgh Rolls can result only in *less cost per ton of steel rolled.*



PITTSBURGH ROLLS
Division of Blaw-Knox Company
PITTSBURGH, PA.

PITTSBURGH ROLLS



Backing up your Back-up Roll Bearings

THAT thin film of oil, shown in red above, is the only barrier standing between your back-up roll bearings and excessive wear.

Squeezed by literally millions of pounds, this oil must resist rupture, stand up for long periods of service, help carry away heat and separate from water.

That's asking a lot from any lubricant. But Gargoyle Vacuoline Oils have proved that they possess the right combination of properties to do this tough job.

In wide use now in many mills, these oils form strong, persistent films to prolong bearing life. Highly stable, they carry away heat without sludging and separate readily from water. Back up your back-up roll bearings now with these outstanding lubricants.

Get this Complete Lubrication Program for all your machines

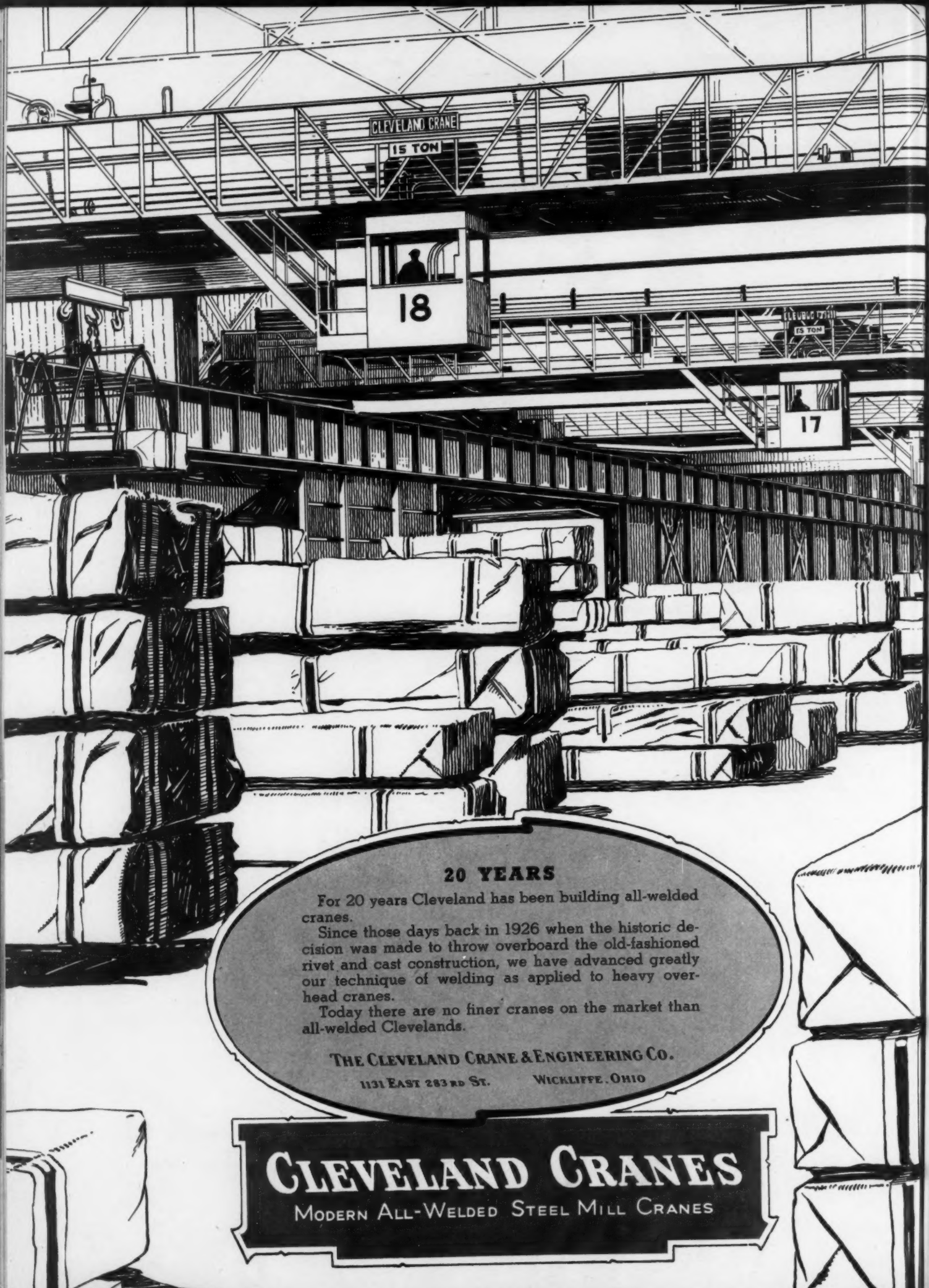
- Lubrication Study of Your Entire Plant
- Recommendations to Improve Lubrication
- Lubrication Schedules and Controls
- Skilled Engineering Counsel
- Progress Reports of Benefits Obtained

Socony-Vacuum Oil Co., Inc.

and Affiliates: Magnolia Petroleum Co., General Petroleum Corporation

TUNE IN "INFORMATION PLEASE"—MONDAY EVENINGS, 9:30 E.D.T.—NBC

GARGOYLE Lubricants



20 YEARS

For 20 years Cleveland has been building all-welded cranes.

Since those days back in 1926 when the historic decision was made to throw overboard the old-fashioned rivet and cast construction, we have advanced greatly our technique of welding as applied to heavy overhead cranes.

Today there are no finer cranes on the market than all-welded Clevelands.

THE CLEVELAND CRANE & ENGINEERING CO.

1131 EAST 283RD ST. WICKLIFFE, OHIO

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

Crops *and* Shorts

OPENING of sealed bids for the $90,000,000 DPC steel plant at South Chicago produced one purchase offer of $17,500,000 from Central Steel Tube Company at Clinton, Iowa, and an offer from Republic Steel Corporation to lease the plant at a sliding scale depending on production, with a maximum estimate of $3,000,000 a year return to the government and a guaranteed minimum of $200,000.

For the Geneva plant a variety of bids were received, including a telegraphic offer from Blue Star Enterprises, Inc., Salt Lake City, Utah, for $302,000,000, and a sealed bid of $135,000,000 from Fred Riley Company, Los Angeles, California. From United States Steel Corporation came a sealed bid of $40,000,000 for the plant plus $7,500,000 for inventory. Colorado Fuel and Iron Company submitted a leasing bid with option to buy.

Kaiser Company could not bid, but entered a plea for scaling down its obligation on its government-financed Fontana plant in accordance with the markdown on the other government-owned plants.

▲

ACCORDING to "Facts and Faces," the house organ of the Yoder Company, "Nobody ever thinks of public ownership until somebody builds something worth owning." Also, "A man is known by the company he keeps; a company by the men it keeps."

▲

COKE ovens, open hearths, blast furnaces, blooming mills, merchant mills, cold strip mills, fabricating facilities — all these and more are included in the list of equipment to be rebuilt and modernized by the steel industry in its $327,000,000 program. This expenditure during 1946 for modernization and improvement covers practically all major producers, and points to good business for equipment manufacturers. It will also put the industry in better shape to meet the competition of light metals, plastics, etc.

▲

AT the recent meeting of the Open Hearth Committee in Chicago, Dr. H. T. Heald, president of Illinois Institute of Technology, spoke on stimulating technical education for the steel industry. It is this department's studied opinion, however, that the good doctor received more than he gave when one of our metallurgical friends, following the speech, gave him this formula for educating young men for industry: 1 — Teach them to think; 2 — Teach them to speak; 3 — Teach them to write; 4 — Teach them that marrying the boss' daughter is no hindrance; 5 — Teach them some technical stuff, too.

▲

THANKS to the steel and coal strikes, steel output for 1946 is not expected to reach 67,000,000 tons of ingots.

▲

IN Switzerland, each member of the National Council is paid for every day that he is present at the session. If he does not answer when his name is called, he loses his day's pay. If we used that system in the United States, at least half of Congress would be forced on to relief.

▲

STATISTICS (those good old friends) show that compulsory dues collected by labor unions from their members amount to nearly $500,000,000 annually — more than all churches and religious institutions combined receive.

▲

THIRTEEN blast furnaces have been declared surplus by War Assets Administration. They are located at Braddock, Chester and Monessen, Pennsylvania; Cleveland, Warren and Youngstown, Ohio; Gadsden, Alabama; Houston and Daingerfield, Texas; Indiana Harbor, Indiana; Granite City, Illinois; and Duluth, Minnesota. These furnaces have an annual capacity of 4,370,000 tons of pig iron, and cost the government $198,000,000.

▲

A RECENT survey shows that impulse buying accounts for 38 per cent of the purchases made in supermarkets. That's what comes of wives having their husbands stop in those places on the way home to dinner.

▲

ON the average, it takes about $7000 of invested capital to make a single job.

▲

A STUDY made by a large corporation clearly revealed that its salesmen had the very human tendency to call on companies where orders were forthcoming, to avoid prospects from whom orders were not usually obtained, and to neglect prospects who were not easy to reach. That's not exactly startling news but it's a poor way to start new business.

▲

A MAN receives little consideration through life, according to the following brief history which some sage has set down: "When he is born, everybody thinks about his mother. When he marries, everybody thinks about the bride. When he dies, everybody thinks about his widow." But we might add: When he drops ashes on the carpet, his wife thinks plenty about him.

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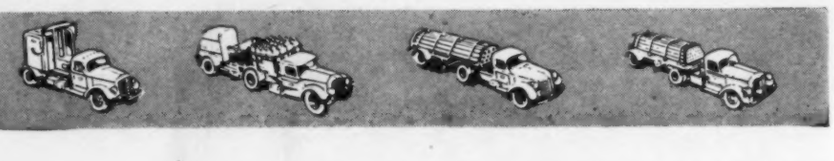

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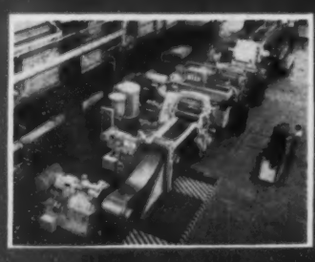

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Salutes the STEEL Industry

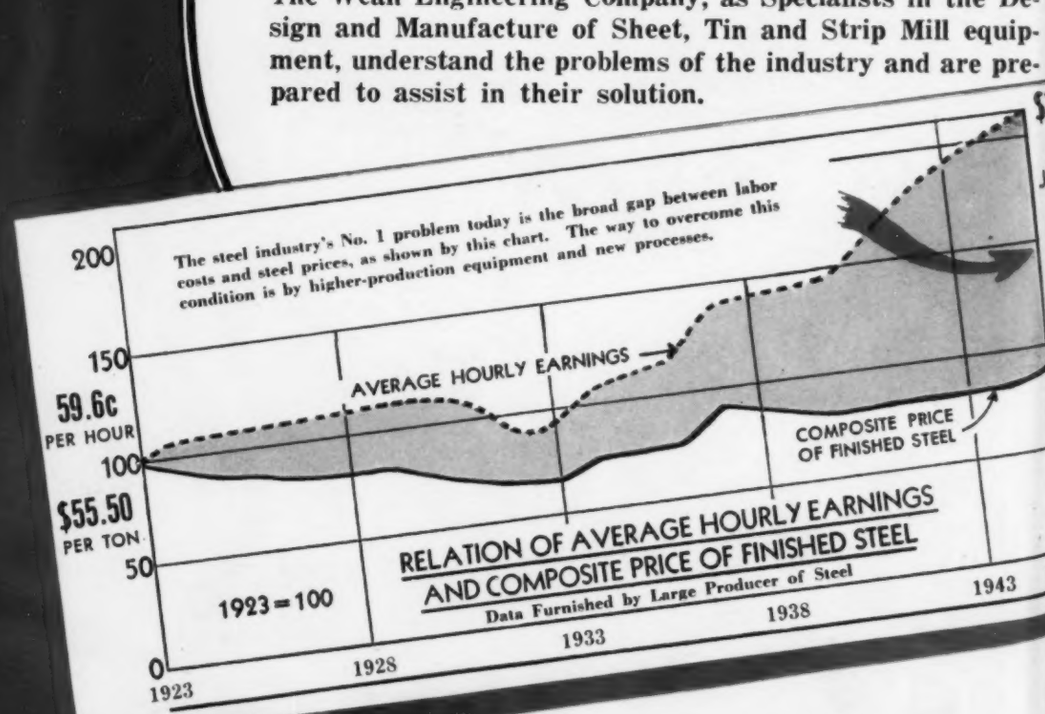
As steel producers once more fulfill the nation's needs, The Wean Engineering Company takes this opportunity to pay tribute to the efforts of the men who are operating this great industry.

The minor price increases permitted the steel industry while labor costs have mounted sharply, present a tremendous operating problem to the hard pressed executives in this great industry.

Increased production and lower costs can only be accomplished by the use of more productive equipment and new processes.

To meet the tremendous new production goals set by men of steel, Wean-Designed, Wean-Built equipment will continue to bring increased output with greater efficiency.

The Wean Engineering Company, as Specialists in the Design and Manufacture of Sheet, Tin and Strip Mill equipment, understand the problems of the industry and are prepared to assist in their solution.


The steel industry's No. 1 problem today is the broad gap between labor costs and steel prices, as shown by this chart. The way to overcome this condition is by higher-production equipment and new processes.
200
150
59.6c PER HOUR
100
$55.50 PER TON
50
0
AVERAGE HOURLY EARNINGS
COMPOSITE PRICE OF FINISHED STEEL
RELATION OF AVERAGE HOURLY EARNINGS AND COMPOSITE PRICE OF FINISHED STEEL
Data Furnished by Large Producer of Steel
1923=100
1923
1928
1933
1938
1943

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Conservation of Utilities IN REPUBLIC'S CANTON PLANT

. . . . the cost of utilities is an appreciable factor in the cost of steel . . . . reducing the quantity of utilities required merits serious consideration, and how this is done in one steel plant is told in the following paper . . . .

by P. L. Walter

SUPERINTENDENT OF MECHANICAL DEPARTMENT

REBUBLIC STEEL CORPORATION

CANTON, OHIO

▲ WITH the prospect of reduced operations in the steel industry at the present time, the re-consideration of various methods and procedures used in the economical utilization of utilities appears fitting. The term "utilities" as used and referred to in this discussion is defined as "plant services and facilities" and includes electric energy, steam, water, air and gas in their various stages and conditions of pressures, temperatures, voltages, etc.

All of these various utilities, directly or indirectly, have as their origin the combustion of fuels, which in the steel industry are almost universally bituminous coals. In the steel producing areas, electric energy is practically always produced from coal burning steam generators rather than from hydro or diesel plants. For the most part, steel plant steam requirements are produced from stoker or pulverized coal fired boilers or boilers using by-product fuels such as blast furnace or coke oven gas which are derivatives of coal. The source of energy for air compressors and water pumping equipment, whether steam or electric driven, is ultimately coal. In this country, there is an abundant supply of coal but the productive capacity available to mine this coal is critical. Government agencies are quite concerned as to whether or not coal production will adequately meet the requirements of home and industry. It therefore seems important that since coal is the major fuel used in the production of utilities, we should investigate any economies that can be made in the consumption of these plant services in order to aid in the conservation of this extremely important natural resource. Also, the conservation of utilities is of national importance rather than important to only the steel industry or to our particular plant.

As with the use of raw materials, modern steel plant practice requires that the various utilities be conserved and consumed economically and to the greatest advantage. The conservation of utilities in a steel plant is essential for two reasons. First because of cost con-

Presented at the Cleveland Session of the Annual Meeting, October 3, 1945.

TABLE I — LOSSES INCURRED FROM WASTE OF PLANT SERVICE

Diameter of opening, inches	Compressed air 90 psi $0.033 per M cu ft		Steam 200 psi — 500 F $0.27 per M pounds		Service water 45 psi $0.01275 per M gallons	
	Cu ft wasted per month	Cost of waste per month	Pounds wasted per month	Cost of waste per month	Gallons wasted per month	Cost of waste per month
1	65,100,000	$2,145.00	7,720,000	$2,085.00	5,170,000	$65.60
7/8	49,850,000	1,644.00	5,900,000	1,593.00	3,920,000	49.70
3/4	36,500,000	1,206.00	4,360,000	1,178.00	2,880,000	36.60
5/8	25,400,000	838.00	3,000,000	810.00	2,000,000	25.40
1/2	16,270,000	537.00	1,940,000	524.00	1,295,000	16.45
3/8	9,120,000	300.00	970,000	289.00	720,000	9.15
1/4	4,065,000	134.00	470,000	127.00	320,000	4.07
1/8	1,017,000	33.00	115,000	31.00	80,000	1.00
1/16	254,000	8.00	29,000	17.00	20,200	0.26

Diameter of opening, inches	Gas 1 psi	Coke oven gas $0.102 per M cu ft	Natural gas $0.337 per M cu ft
	Cu ft wasted per month	Cost of waste per month	Cost of waste per month
1	5,950,000	$607.00	$2,002.00
7/8	4,550,000	464.00	1,534.00
3/4	3,350,000	342.00	1,128.00
5/8	2,200,000	225.00	742.00
1/2	1,490,000	152.00	503.00
3/8	832,000	84.80	280.00
1/4	373,000	38.40	125.60
1/8	93,000	9.48	31.35
1/16	25,000	2.35	7.75

siderations, since the cost of utilities is a considerable part of the cost per ton of product. This varies greatly, depending upon the type and quality of the steel produced, however. Second, the limited availability of some utilities resulting from the limited facilities for their production or the scarcity of the materials from which they are produced requires that the services be used most conservatively. Too often however, especially with operating personnel, utilities are considered only as being necessary and available and no thought is ever given to the costs or difficulties of production and distribution.

One of the most effective methods of combating wasteful, uneconomical practices is by the establishment of an intensive educational program. All of management and departmental supervision is made conscious of the cost of their department as a result of the wasteful use of utilities. This is effectively brought to their attention by monthly cost reports which indicate metered quantities of each utility consumed, the unit cost and the total cost to their department. The cost of waste of power services is also brought to operating personnel's attention by the circulation of charts which indicate the quantity and cost of waste at the prevailing unit cost of each utility. Such a chart is shown in tabulated form in Table I. The unit costs indicated are only assumed rates and do not represent present utility costs in our plant. Data is effective in bringing about the need for the control and careful use of these plant services.

Control of utilities losses is also affected by a detailed inspection program. All of the utility department personnel act as inspectors and are constantly on the alert for leaks and wasteful practices. They are constantly bringing to the attention of operators throughout the plant uneconomical practices they note. Leaks of all kinds are repaired as soon after discovery as is possible or as operations permit, but once each month inspections of these various service lines is made and a detailed report submitted. At mechanical maintenance meetings, the importance of immediate repair of these leaks is stressed and mechanical maintenance supervisors are expected to make the necessary repairs promptly. The plant oxygen distribution system now requires the full time of one inspector who patrols these lines and immediately repairs leaks which occur from time to time. Metering this service has proven that the cost of such protection has been returned many times.

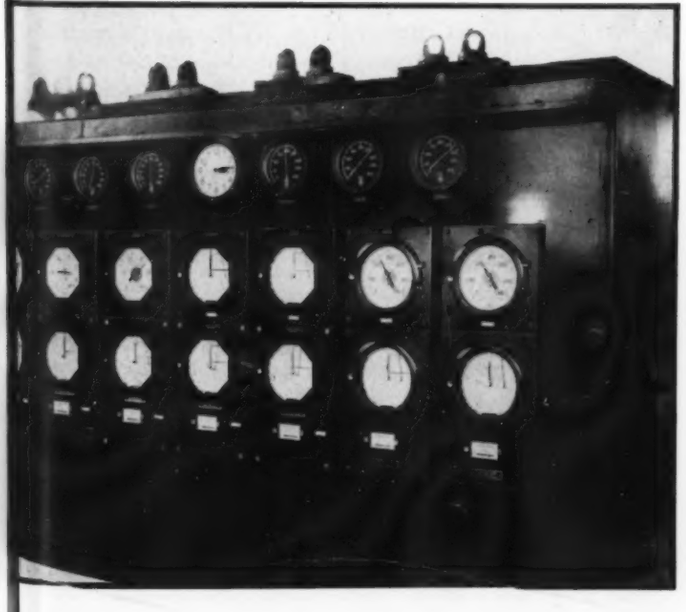
Combustion department engineers are very effective in helping to consume all utilities to the best advantage. They conduct combustion analyses, boiler tests, run checks for leaks, calibrate and maintain all metering equipment, engineer modern and more efficient installations, make suggestions for improved operation and many others.

An organization which has been educated to such extent that they are fully aware of the cost of wasteful utilities consumption and then are cooperative to the extent of carrying out requests to conserve utilities and

report leaks and other waste is a great asset in the economical utilization of these plant services. To everyone's advantage, this is a situation which exists in our plant at present, and although it required considerable pressure and effort, it has been very worthwhile. Today, even the plant protection personnel in their tours of the plant are reporting unnecessary lighting, unused running water and leaks.

A comprehensive, accurate system of metering all utility services to consuming departments is an important implement for use in combating waste. In our plant, reliable metering equipment strategically located for frequent observation by operating personnel has saved many pounds of water and steam. The meter panel in Figure 1 contains indicating, recording and integrating flow meters for steam to coke plant and blast furnace, boiler feed water to two boiler houses, treated water to the steel works, and water to the coke plant and blast furnace. Above each flow meter is a pressure gauge indicating line pressure on the particular service being delivered. By observing this metering equipment, an operator quickly notices any deviation from normal requirements. As soon as this occurs he contacts someone in the consuming department for an explanation. Frequently, this increased flow to a department is only the result of someone having forgotten to shut a valve or some similar item and the increased consumption is quickly restored to normal by this reminder. If no explanation for the increased demand is available, then an investigation is made and as a result a leak or some other faulty condition is detected. In addition to the help metering provides in maintaining a minimum consumption, it also makes possible accurate cost distribution figures which give credit to consuming departments which use utilities in an economical manner.

Figure 1 — Flow meters for distribution of various utilities.



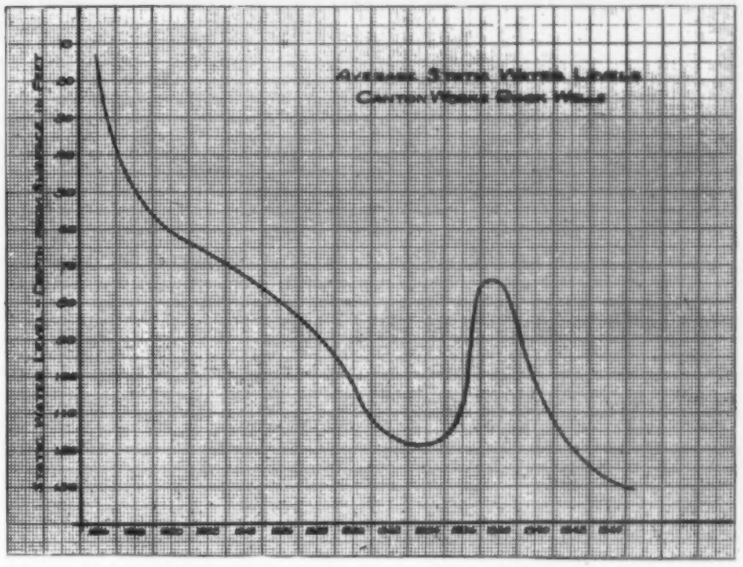


Figure 2 — Average static water levels of rock wells.

WATER

Republic's Canton plant, because of its inland location and lack of any quantity of natural surface water supply is by necessity forced to utilize in every way possible its very limited water resources. For the most part this is accomplished by a recirculation and reclamation system which uses, reclaims and reuses the same water on applications which progressively require water of lower quality so far as chemical and physical properties are concerned. The two sources of water supply are a series of deep wells and a small creek.

When the first group of this series of wells was drilled in 1916, the average static water level was approximately 13 feet from the surface. The trend or gradual depression of the average water table level for the wells in this plant is presented in Figure 2. The temporary elevation of this static water level is the reflection of reduced business activity when fewer wells were pumped. Since 1940, as a result of the industrial expansion of this territory, studies indicate that approximately twice as much water is being removed from this basin as have been available for replenishment. The downward trend of this curve definitely indicates the need for intensive conservation of water in this plant, but since this curve is typical for many localities, consumption of water must be regulated and conservation of water supply is essential in most steel producing districts.

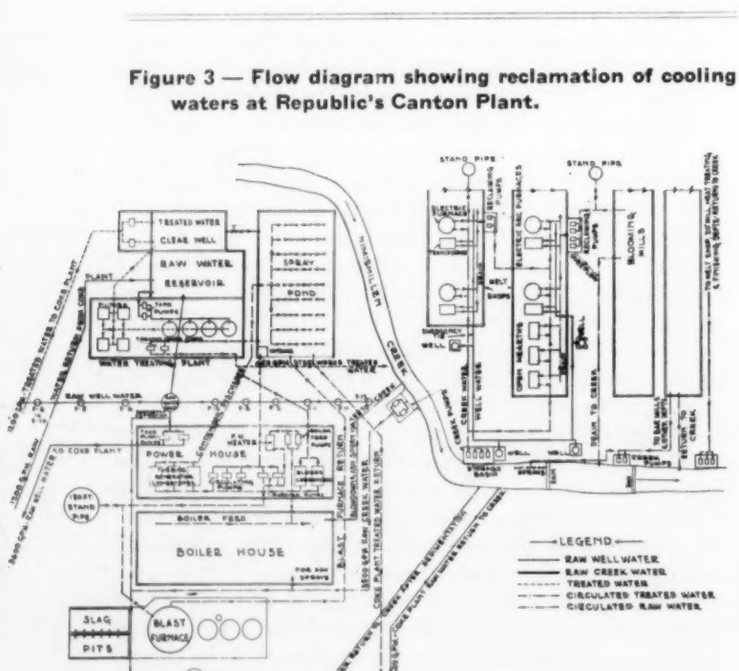
Because the water supply from these wells is so vital to operation in the summer months when additional cooling is required and when the stream flow is at a minimum, these wells are rejuvenated and the water levels restored by taking as many of them as possible out of service and reducing the pumpage from others during the winter months while stream flow is at a maximum and temperatures are low. This procedure also results in power savings, since the pumping head

is reduced by not having to raise each unit of water the distance from the pumping level to the surface. In our plant pumping heads are maintained at a minimum and to a value which will just deliver sufficient water for what we consider adequate cooling. Standpipes are kept only as full as absolutely necessary and all pump discharge pressures are selected as low as is practical. Any increased pressure requirements can easily be obtained by slightly modified pump impeller designs.

Nimishillen Creek, which flows through the plant has its source approximately nine miles north east. Before reaching Republic's property, it is used as water supply by a sheet mill and by a sizeable railroad shop. It is also somewhat contaminated by the drains from several strip mines. Generally however, it is a comparatively good source of industrial water supply. Its volume varies from a roaring freshet of many thousands of gallons per minute in rainy and flood seasons to a trickle of about 500 gallons per minute during the warm summer weather, and its temperature varies from freezing to 95 degrees F. These two sources, the creek and the wells, supply the steel plant's entire water requirements.

Referring to the flow diagram of Figure 3, the water from a series of thirteen wells is pumped at the very low discharge pressure of from 3 to 5 psi to an underground raw water basin which does not have sufficient volume to act as a reservoir, but serves as a surge tank to absorb temporary fluctuations in pumping capacity or demand. From this raw water basin, the cold, clean well water is pumped at 70 psi to the coke plant for use on the final coolers and benzol plant wash oil coolers. After this water has served one use for cooling and has acquired an increase in temperature of several degrees, it is returned by gravity to a raw water reservoir. Any water in excess of that needed for coke plant cooling is overflowed from the raw water basin to the raw water reservoir and is available for use in the water treating plant.

Figure 3 — Flow diagram showing reclamation of cooling waters at Republic's Canton Plant.



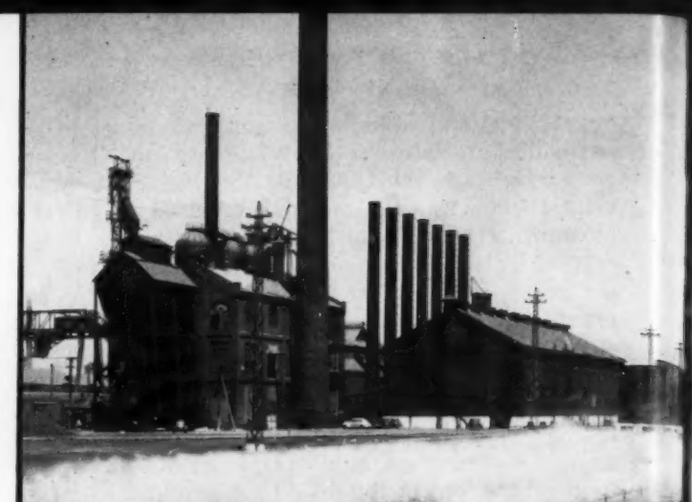


Figure 4 — Spray pond for cooling and recirculating water.

The treating plant is a batch process cold lime and soda ash system, and water is pumped from the raw water reservoir directly into the tanks. Here the chemicals are added and after agitation and precipitation, the treated water is passed through gravity filters into the treated water clear well. From here approximately 1200 gallons per minute of treated water is pumped to the coke plant for use on the primary coolers. Pumping pressures of 70 psi are required because of the elevation of these coolers. This treated water has a temperature of between 65 to 70 F and the advantages of using this cold treated water are many since coke plant yields are high and cooler maintenance is low. This water picks up considerable temperature and so it is returned by gravity to the spray pond where it serves as make up for evaporation losses and for the water which is pumped from the spray pond for other uses which will be described later.

This spray pond which serves as the nucleus for the recirculation system is pictured in Figure 4 with the boiler house, blast furnace, power house and water treating plant in the background.

A suction line from the spray pond supplies two sets of pumps circulating treated spray pond water. The three circulating water pumps deliver approximately 36,000 gallons per minute at 20 psi to turbine generator condensers and to blowing engine condensers and discharges through the spray nozzles into the pond. Two furnace pumps supply the blast furnace with treated and softened water for hearth, bosh and stack plate cooling and this is all returned to the spray pond for temperature dissipation and recirculation. This water is delivered at 40 psi which is just sufficient to produce enough flow for adequate cooling. A 120 foot standpipe is used in connection with this circulating system for emergency protection and its additional unused elevation is available for use in case more water or higher stack cooling on the furnace is ever required. These pumps also furnish the make-up to the boiler feedwater heater. The spray pond water has an average total hardness of from 8 to 10 parts per million and the residual calcium hardness is taken care of by using phosphate internal treatment in the boilers. Because the quantity of water required is less than 20 per cent of the total feedwater, using this water for make up is not a great disadvantage and the chemical

correction is not abnormally expensive. The normal tendency of spray pond water to develop concentrations of solids because of evaporation losses is averted by pumping an additional 450 gallons per minute from the pond to the steel works for use as boiler feedwater make up and for use in locomotives.

Approximately 3500 gallons per minute of water from the creek is pumped at 70 psi and is distributed for such use as boiler house ash hopper sprays, blast furnace slag pit cooling and gas washer water. All this water is returned to the creek by way of various drain systems after passing through filters or sedimentation basins of several types to remove entrained ash, slag and suspended flue dust. Even though the creek is not passing the required volume of water, 3500 gallons per minute or more is continuously available since all raw well water which has been sufficiently contaminated so that it is not suitable for treating plant consumption is returned to the creek.

In this blast furnace and coke plant division where large volumes of various types of water are consumed, the drains from any type of unit or piece of equipment are carefully investigated for possible reclamation before being sewered. The dire necessity for conservation of water in the plant is indicated by the following examples in which even small quantities of water are reclaimed to advantage.

In the coke plant, drains from seals and coolers are piped to the quenching station sump where the water serves as make up for evaporation losses from quenching. From this sump, water is pumped by large volume low head equipment to a storage tank. When quenching, this water filters through the coke and returns to the sump from where it is recirculated through the same cycle. With this system, many services are obtained from the same water and the make up is water which ordinarily would be wasted. All raw well water which does not become contaminated in any way is returned from the coke plant for use in the water treating plant and after being used once for cooling, it normally furnishes all water requirements for the treated water system. We use raw well water on turbine bearing lubricating oil coolers and after this service it is drained into the raw water reservoir for further use. Condensate from blowing engines carries entrained particles of cylinder oil which makes it unsuitable for delivery to the feed water heater. To save this water, it is passed through oil separators and then drained to the water treating plant. All pump packing leak-off drains are piped to a common sump from where they are reclaimed for use in the water treating plant. From the boiler house, all boiler blow down and ash spray waste water is returned to the creek for reclamation and further use. Wherever possible, all drinking fountain drains are piped to the raw water basin and used again. The back washwater from the water treating plant filters is drained to a settling basin which overflows to the creek and this water finds its way to other use.

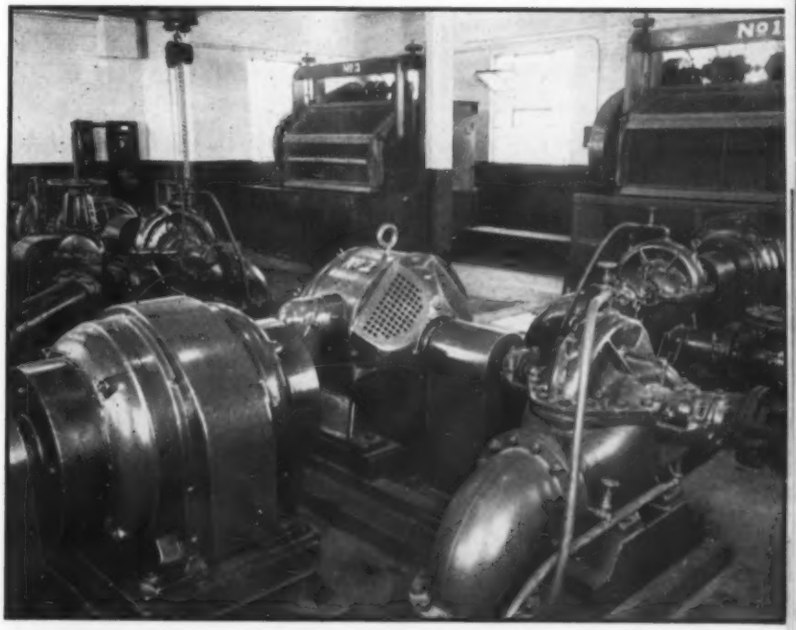
"Steel Works" is the term used in the Canton plant to differentiate the melting and rolling area from the blast furnace and coke plant division. In the "steel works" part of the plant, another series of rock wells is strategically located. Water from the wells is pumped directly into a distribution system which supplies the water to a battery of electric furnace transformers. These transformers are large, heavy duty, three phase transformers of 12000 to 15000 kva capacity and require clean, cold water with little tendency for precipitating scales or solids. This cooling water circulates through the cooling system of the transformers and drains into a sump or reservoir which in our plant is known as a hot well.

Figure 5 pictures the upstream dam with the storage basin and the creek pump house in the background.

Figure 5 — Dam, storage basin and pump house. The reclaiming sprays are operating and there is no flow over the crest of the dam.

▲

Figure 6 — Pumps and screens in creek pump house.



This picture also shows flushing nozzles which keep the surface debris from fouling the trash racks and the extension on the pump house which encloses the traveling screens. The contracted weir in the crest of the dam is dry, indicating that more than the flow of the creek is being pumped from this storage basin. The riffles along the left bank of the creek indicate the discharges of the water from the blast furnace gas washer and the coke plant which are also indicated on the flow diagram of Figure 3. The interior of the creek pump house with part of the pumping equipment and the traveling screens is shown on Figure 6. These pumps are under automatic control which puts them into operation or takes them out of service in accord with preestablished system pressures of standpipe elevations. This control system eliminates the probability of wasted water resulting from excessive pressures or overflowing of standpipes.

Water from the creek pumps is delivered into a distribution system which supplies all doors, door frames, electrode coolers, and all other cooling requirements of electric arc type and open hearth furnaces. Open drains from all of these cooling applications flow by gravity into drain lines which deliver this water to the same hotwells as the well water from the transformers. This furnace cooling water acquires considerable temperature from the cooling applications and in warm summer days, the temperature of the hotwell water often reaches 120 F. Water at this temperature is still very satisfactory for most cooling applications. Consequently, this mixture of creek and well water in the hotwells is reclaimed for further use and the reclaiming pumps pictured in Figure 7 and also shown on the flow diagram, deliver this water to the blooming mill for use on rolls, hydraulic equipment and general mill use. These reclaiming pump installations consist of a group of pumps of similar characteristics for parallel operation and have capacity and sufficient pumping head to deliver the reclaimed water to the point of next consumption. Float controls which are visible in the picture operate these pumps according to an established hotwell level.

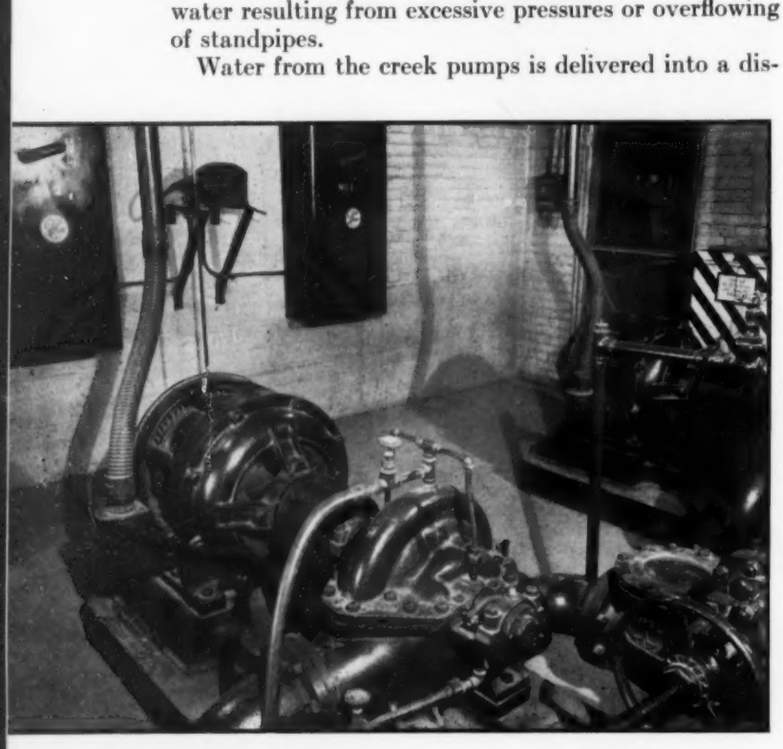
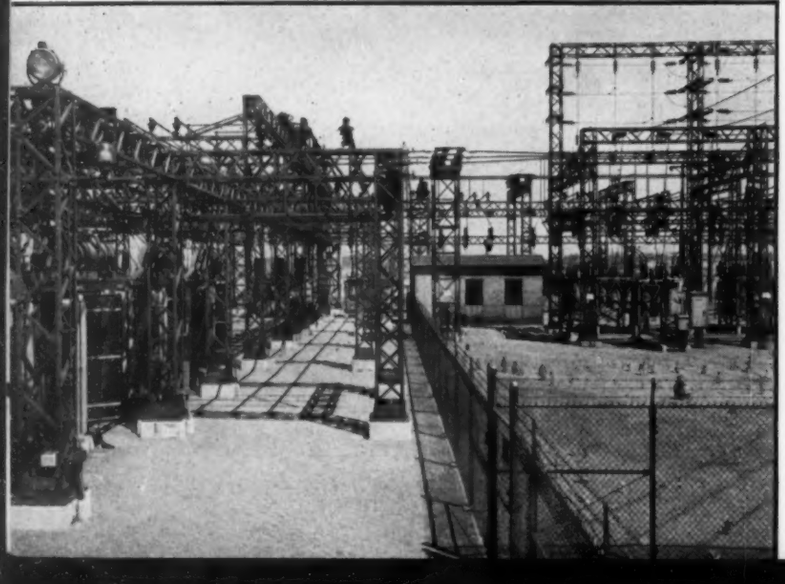


Figure 7 — Hot well pumps which reclaim water for recirculation.

▲

Figure 8 — 22 Kv distribution substation at Canton plant.



From the blooming mills where this reclaimed water is used, it is drained to the creek at a point below the dam shown in Figure 5 but above a second dam which is located approximately 1200 feet down stream from the first dam. At this dam, a second creek pumphouse is located. The pumps at this dam serve two uses depending on the quantity of creek water available. When there is sufficient flow in the creek, these pumps supply water directly into the service water system for water to the bar mills and finishing departments. All of this water after being used is drained back into the creek at a point down stream from the second dam. During seasons when the creek flow is very limited, the pumps at the second dam pump water back up stream above the first dam and through a line of sprays for a certain amount of cooling. These sprays are visible in Figure 5 which shows them in use during July 1945 when there was not enough creek flow to spill water over the crest of the dam.

Below the second dam, a third creek pumphouse is located and its pumps supply cooling water to the 20 inch mill, heat treating and other finishing departments and then it is drained to the creek. At the location where this water reenters the creek, this stream leaves our property after having been used over and over again to serve many cooling applications satisfactorily.

ELECTRIC ENERGY

Electricity, because of its almost universal adaptability to any power application, the ease of distribution to points of consumption, the extent to which it can be controlled, and its relatively low cost has become the most widely used source of power in steel as well as in all other industry. For these same reasons, little consideration is given to the conservation or economical consumption of this fundamental plant service. Figure 8 shows a part of one of the distribution substations in our plant. From its size, some idea as to the power requirements of this steel plant can be obtained.

The conservation of electricity is important whether

or not a mill generates its electric energy requirements by purchasing coal from an outside source or if it receives its electric energy from a central station system, which in turn purchases coal for the generation of the power sold. In considering the economical utilization of electric energy in a steel mill, it is of primary importance that extreme care be used in the selection of the equipment. Each installation must be carefully designed and engineered. After installation, only limited changes are possible to improve efficiency or operation while still retaining the original equipment. The use of an over-sized motor, for example, results in losses such as copper, hysteresis, and windage losses, which produce no effective work and which would be eliminated by the use of the correct size motor. Selection of correct and adequate control equipment will contribute considerably to the elimination of losses and to efficient operating conditions. Regardless of the type of job to be performed electrically, the correct application as to size and type is necessary not only for better operation, but also in the interest of efficiency and conservation.

After having carefully selected the proper equipment for the various applications of electric energy in the plant, it is then necessary that attention be given to the proper operation of the equipment. One of the most important factors and one which requires serious consideration is that of demand control. There are, of course, many uses of electrical energy in the steel plant over which one can exercise little or no control as to the time the demand of these individual applications occurs. There are, however, many operations which can be regulated and scheduled so as to result in a mill demand which will be conducive to economical utilization of electricity.

Whether electricity is generated or purchased from a power system, demand control is important. It might be said that the most economical operation from the standpoint of utilization of electric energy would be to have uniform demand, or in other words, one hundred per cent load factor. In some types of industries, this is possible. It is obvious that it is practically impossible for the steel industry. When the electric service is purchased from a power company, demand control is of primary importance due to the fact that central station power rates incorporate demand charges as well as energy charges.

In our plant, there is a method of demand control which works out very satisfactorily. With scheduled operations for the approaching month as a criterion, we determine the maximum demand we desire to create during the coming billing period and our load dispatcher who is responsible for our demand control has at his meter panel a demand indicator which keeps him constantly informed as to the immediate and average one-half hour plant demand. As the actual demand approaches the established value for that month, he can arrange to curtail certain operations and in this manner keep the actual load within the predetermined demand value. The larger part of our electric energy is purchased from a power system and our demand meter is timed and synchronized with that of the power company for accurate control of demand, thus obtaining the lowest possible rate. We have quite a number of electric melting furnaces, some of which will be in all stages of the melting cycle. Temporarily taking out of service those units which are in such condition that removing the power will cause no detrimental affect to steel quality, makes it a relatively simple matter to maintain demand control within a predetermined value each billing period.

The steam producing equipment furnishing steam to power generating units necessarily requires periodic maintenance. Repairs to the boilers and to turbine auxiliary equipment is scheduled coincident with repair periods on the mills or at a time when electric furnaces are out of service for maintenance. Operating in this manner eliminates the need for increasing the purchased power demand during periods of reduced generation. By dispatching electric furnaces and by scheduling boiler and turbine outages to coincide with mill and furnace repairs, our plant is operated at an average monthly load factor of 76.5 per cent. We consider this figure to represent a good load factor considering the widely fluctuating consumption and high instantaneous demands required by electric arc melting furnaces.

In addition to proper selection of equipment and demand control, there is another factor in the conservation of electric power in the steel plant which needs consideration and that is the matter of losses. By the proper selection of equipment and by well engineered installations, we automatically minimize to the greatest extent the inherent losses in the various types of electrical equipment. The losses then to be considered are those resulting from low power factor and those inherent in the distribution system.

Low power factor has several detrimental results which adversely affect the economical utilization of electric energy. Low power factor decreases the load capacity of the distribution system and therefore diminishes the ability of the system to carry kilowatts which do the useful work. It also makes it more costly to transmit each kilowatt due to the increased copper losses. It also has an effect by depressing the voltage due to the increased current resulting from low power factor, which may adversely affect production by making motors sluggish, dimming lights and slowing up heating equipment.

Since at low power factor the circuit must carry the amperes of kilovars in addition to the amperes of kilowatts, it is obvious that distribution feeders must be larger for a given load at low power factor than at high power factor. This resistance or I^2R losses of electrical conductors are proportional to the square of the current flowing. It is therefore advantageous to maintain high power factor in circuits in order to minimize these losses. In purchasing electric energy from a power system, it is desirable to maintain high power factor because electric rates incorporate a power factor clause which penalizes the customer for poor power factor.

In all steel plants there are many applications where synchronous motors, which can be over-excited to generate a leading reactive current, can be used to advantage in improving the average plant power factor. In our plant, this is done wherever a drive with the characteristics of synchronous equipment is practical. All air compressors, motor generator sets, exciters, frequency changers and similar equipment are driven by synchronous motors. The synchronous motor drive

Figure 9 — Synchronous motor drive for frequency changer.

of a frequency changer supplying power to a large induction melting furnace is pictured in Figure 9.

Static condensers whose sole function is to deliver leading reactive kilovolt amperes are suitable for use in the steel plant for neutralizing the lagging magnetizing currents of induction motors and other inductive equipment. In our plant, static condensers of the correct capacitance are located near individual departments or in substations feeding particular areas in which the non-corrected power factor is low.

Temperature is the limiting factor in the loading of electrical equipment. Generating equipment can be so loaded to carry as many amperes as the temperature of the windings will permit. In our generating plant, we overexcite generators so as to carry the rated amperes regardless of the kilowatt load the unit is carrying. With this method of operation, any amperes in excess of those required for generating the actual power kilowatts are available for correcting power factor. On long blast furnace checks, when we do not have sufficient steam from solid fuel, we reduce the kilowatt load on the generators and operate the equipment at loading power factor during these intervals. During times when boilers are off for maintenance, it is necessary to reduce our power generation. At these times also, we continue to operate the generating equipment to supply capacitive reactive kilovolt amperes for power factor correction.

In the more sizable plants with larger electrical loads, it is usually advantageous to use synchronous condensers for power factor correction. Because the corrective capacity of the methods outlined above were not sufficient to bring the average power factor to the desired value, synchronous condensers with a total capacity of 40,000 kva have been installed in our plant. One of these condenser units is pictured in Figure 10. These condensers have been installed with automatic control devices which put the equipment on the line automatically and then regulate the field excitation so as to obtain uniform preestablished receiving end voltage, and predetermined instantaneous and average monthly power factors. At present, August 1945, we are operating with peak loads of 120,000 kva and a daily consumption of 2,000,000 kwhr while maintaining average monthly and peak power factors of unity or 100.0 per cent.

In all steel plants, there are some electrical operations which are intermittent and where equipment may idle on the line. The idling of this equipment on the line creates additional losses which can be eliminated by deenergizing the equipment from the system when it is not doing any useful work. In this connection, we have in mind the disconnection of transformer banks during periods when the equipment served by these transformers is not in operation. Charging currents of transmission lines and especially cables and the magnetizing currents of transformers will produce considerable losses, especially if the units have sizable ratings. Then too, there are certain motor applications where motors may idle on the line for a considerable length of time without doing any actual work. This equipment may be deenergized without adversely affecting production in order to conserve the power consumed in losses by this equipment. In our plant we have made a study of the power consumption per unit of time for mill drive motors operating idle as compared with power requirements for overcoming inertia and accelerating the mill after it has been shut down. From this we have determined and have established a definite time or delay in which the mill is allowed to idle. After this time, or if it appears that the mill will be down for at least this established length of time, all electric equipment is shut down.

Considerable quantities of electricity may be conserved as the result of a study of the plant lighting system. It is becoming increasingly important that the lighting system be so designed so as to provide adequate illumination which is so necessary for relieving eye strain and insuring maximum production. The lighting system should be carefully designed and the equipment selected should be that best suited for the particular application. Correct design and proper installation of the lighting system is not enough. The lighting equipment after installation must be maintained in efficient operating condition. In order to accomplish this, a regular system of lighting maintenance must be established in which defective lamps and reflectors are replaced and in which the lamps and reflectors are cleaned at definite intervals. The accumulation of dirt on lighting equipment reduces the light output to a marked degree and inasmuch as light itself is all that is being purchased, it is necessary that the equipment be regularly maintained to derive maximum benefit from the lighting installation.

Modernization of existing equipment invariably pays large dividends in the form of power savings, and all present installations should be studied with the idea of investigating possible savings which can be affected by slight changes or additions toward a more efficient operating unit. In our plant, the conversion of bar mill roll neck bearings from the original bearings which were difficult to keep lubricated, to water lubricated fabric bearings has reduced the mill friction load by approximately 45 per cent. All new motor equipment, wherever advisable is being purchased with anti-friction bearings, and all older sleeve type bearing motors are being changed over to anti-friction bearing equipped motors by installing new adaptor type end bells. Change over bearing brackets for most all centrifugal pumps are now available. The power savings resulting from conversion to anti-friction bearings on pumps will pay for

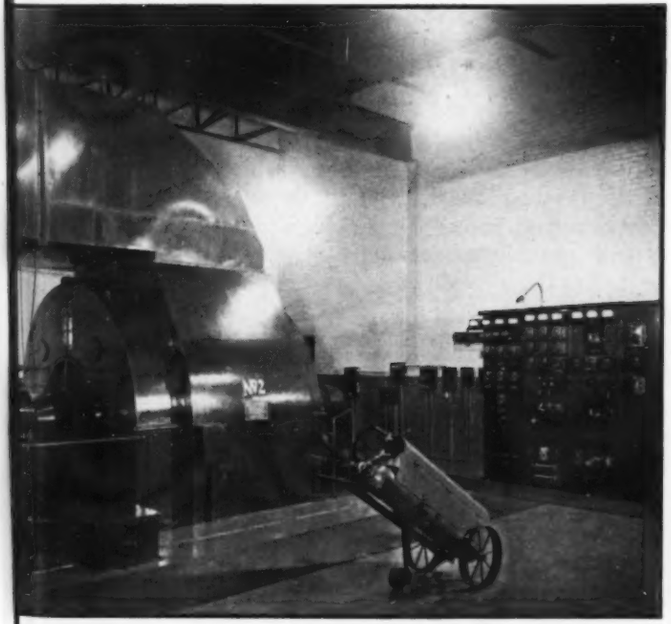
the brackets in approximately one year. Manual and periodic lubrication of mechanical equipment is very wasteful of lubricant and ineffective so far as lubrication is concerned. Complete automatically timed and operated lubricating systems offer valuable returns, not only in reduced maintenance costs, but also in power savings resulting from continuous and adequate lubrication. Modern motor controls such as the electronic and field regulating types now offered by leading manufacturers are valuable in effecting electric energy savings. Not only are these controls in themselves more efficient, but various types of the newer controls when applied to electric furnace electrodes, have brought about an increase in the average operating power factor of the furnaces because of their improved time characteristics.

Various conversions, new applications and the solutions of individual problems which ultimately result in power savings are numerous and the opportunities for conservation of electric energy by these methods are forever presenting themselves. However, so far as the conservation of electric service in the steel plant is concerned, the principal methods by which the maximum utilization can be obtained are first, by the proper selection of equipment so as to secure the most economical operation of the individual applications, second, by maintaining demand control so as to utilize to a maximum extent the power available and to benefit by the rate reductions it provides, and third, to minimize losses in the electrical distribution system by power factor correction and by proper design and installations.

COMPRESSED AIR

Compressed air is one of the most expensive of all plant utilities and hence its conservation is of extreme importance. Great economies can be realized by the proper choice of equipment originally, and by correct installation of the compressor units and the distribution system. However, it is not often that the opportunity for installing new equipment avails itself and any savings or efforts at conservation must be along the lines of consumption or operation.

Figure 10 — Synchronous condenser for power factor correction.



In our plant, the savings resulting from the centralization of compressing equipment was very worthwhile. There was a time when small, single stage, inefficient compressors were scattered throughout the plant in or near consuming departments. As expenditures permitted, this scattered equipment was abolished and large efficient compressors were installed at a central location where they could be properly maintained and attended by one operator. Distribution lines were piped throughout the plant to consuming departments. At present, we have all of our air compressors at three locations between which connecting air lines would not be practical. When this compressor equipment was centralized, we were able to install efficient units equipped with automatic valves of the plate or channel type on which maintenance was low rather than using the mechanical valves of the old, smaller equipment. These compressors are provided with large capacity inter-coolers and by keeping these auxiliaries clean and furnishing them with cold water, compressor efficiency is boosted.

Old steam driven compressors have been replaced by electric driven units on all installations except where the exhaust from steam compressors can be economically used for processing or feedwater heating. This type of conversion does not actually reduce or conserve any quantity of compressed air, but it is effective in lowering compressed air costs and this in effect is what is ultimately intended by a conservation program. The use of automatic pressure regulating equipment on compressors also results in lower power costs for compression. With this equipment, as preestablished pressures are obtained, the regulator opens clearance valves which reduce the output of the cylinder. As the regulator controls the volume of air delivered, the power input to the motor is varied and consequently so long as the system pressure is maintained the only power input to the compressor is that required for windage, inertia and friction losses. Along these same lines, considerable reduction is compressed air costs can be obtained by compression and distribution at the minimum pressure at which satisfactory operations can be maintained. In our plant, distribution lines are so arranged and the compressors are so valved that air is distributed at two different normal operating pressures. The higher pressure system which operates at approximately 120 psi furnishes the steel conditioning departments where the higher pressures are necessary to drive the heavy chipping tools for conditioning alloy steels. The lower pressure system operating at approximately 90 psi is for general plant use.

Aftercoolers are installed on all main distribution lines and for effective operation they are supplied with as cold water as is available in the plant. Moisture drains from this equipment is trapped. Moisture in compressed air is directly influenced by atmospheric

conditions. What moisture is not removed in the inter and aftercoolers passes on into the distribution system. On long runs of air line, the high compression temperatures are gradually lost until the saturation temperature is reached. At this point, the moisture will begin to be precipitated and will cause difficulties in air applications. This condensate should not be removed by allowing open drains to blow. In our plant, water legs are installed at strategic locations and these water legs are equipped with air traps which dispose of accumulations of water without waste of air.

It is not possible to remove all of the moisture in compressed air by these methods and often on drops and dead ended lines great quantities of air had to be discharged to the atmosphere and wasted before dry air was obtainable. To prevent the loss, porous stone filtering devices have been installed at such locations. These filters remove entrained moisture and suitable air is available almost immediately.

In this plant perhaps the greatest quantity of air was conserved by discontinuing the use of compressed air for air-lift pumping of deep wells. With the rapidly receding water levels in these wells, decreased submergences made the consumption of air and cost of pumping water by this method prohibitive. All wells are now pumped by deep well turbine type centrifugal pumps and the resultant savings have shown excellent returns.

Cooperative consuming departments, alert to avoiding wasteful consumption of utilities can do most to limit the quantities of air needlessly used. We are continuously noting and discouraging such practices as the use of high pressure compressed air for cooling purposes and for supplying combustion air to certain gas and oil burning applications and we recommend instead the use of low pressure fans and blowers which are cheaper and operate more efficiently.

Uneconomical utilization of compressed air is very costly, but when properly applied and controlled it is one of the most useful of plant services.

STEAM

The cost of producing steam has increased considerably in recent years, principally because of great increases in the price of fuel. For this reason, the correction or elimination of any possibility of wasteful steam consumption is much more worthwhile than ever before. Radiation and condensation losses on distribution steam lines are not readily visible nor measurable, but on an entire steel plant system they represent considerable loss. Calculations reveal the magnitude of heat and the quantity of fuel wasted which can be prevented by proper steam line insulation. We attempt to keep the insulation on steam lines of all sizes and lengths properly maintained. Figure 11 shows an overhead steam main which we consider to be properly protected. We endeavor to keep the exterior waterproof covering in good condition and free of openings or leaks. This preventive maintenance protects the actual insulating material from deteriorating and this program is also less

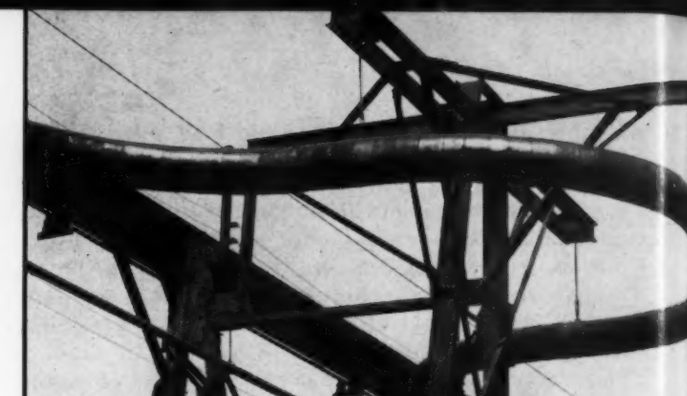


Figure 11 — Properly maintained steam line insulation.

expensive than allowing the more costly magnesia material to be lost and then replaced.

Throughout the plant there are numerous pits, sumps and tunnels which require frequent dewatering. The replacement of extremely inefficient syphons, which are often left to blow through until the pit again fills with water, with float controlled electric sump pumps has saved much steam and many tons of fuel. Portable gasoline driven pumps are doing many of the jobs previously done by large capacity syphons.

Due to recent plant expansions without an increase in steam producing capacity, it was necessary to use industrial type, gas burning unit heaters for space heating in order to have sufficient steam for steel conditioning and other processing. These performed very satisfactorily and made available sufficient steam to operate the producing departments. To save additional steam for this purpose, infra-red electrical equipment has replaced steam heated drying equipment.

Steam pressures on boilers and in the distribution system are not always maintained at design values. As with compressed air and water, savings can be effected by operating at the minimum pressure requirements. This reduces line losses, required heat input to the steam and limits the actual flow.

Wherever steam is used for processing, savings can be realized by the installation of proper control equipment. This equipment should be used to maintain constant flow, pressure or temperature. When this control is attempted manually, steam is usually wasted by having these conditions higher than what is actually required.

By replacing steam operated pumps with electrically driven equipment for producing hydraulic water for mill use, approximately 15,000 pounds of steam per hour were saved in addition to making possible lower hydraulic water costs. Wherever the exhaust cannot be used to advantage, we have attempted to replace steam by electrically operated pumping equipment.

Our inspection system and leak report is very effective in reducing losses from this source.

A power and boiler house is usually one of its own best customers. Operators of this department set an example for proper operation and should be certain that all steam consuming equipment is well maintained and operated at peak efficiency. The over-all heat balance of the plant is carefully watched to see that feedwater temperatures are as high as possible and that exhaust steam is used to the fullest advantage. Condensing equipment such as turbine generators and blowing engines are operated at the highest possible vacuum, and the performance of this equipment is maintained by daily checks.

Even though a reserve supply of steam capacity were available, each installation would be studied for cost and consumption figures and comparisons of other methods for performing the job would be made before applying steam.

FUEL GASES

Although usually considered as utilities, in this plant gas fuels do not come under the control of the utilities department but are under the complete regulation of the combustion engineers. Coke oven, producer and natural gases are used as fuels on open hearths, soaking pits and other metallurgical furnaces.

Coke oven gas is used to the maximum production capacity and its use is controlled by dispatching of the gas to consuming departments according to the volume available as indicated by the height of the gasholder pictured in Figure 12. When it cannot be used to advantage on mill furnace applications, as a last resort it is dispatched to the boiler house and used as an auxiliary fuel on blast furnace gas fired boilers.

Gas was being wasted as a result of its being inefficiently used on applications from indiscriminate connections by millwrights, pipe fitters and operators. To eliminate this practice, it is now necessary to have the approval and authorization of the combustion engineer and the superintendents of both the mechanical and electrical departments before any service connections can be installed. This restriction applies to all connections for steam, water, air and electrical systems as well as to gas.

All gas services are distributed at very low pressures, but leaks do occur. The gas company serving this area has been very cooperative in providing special equipment and aid in locating and eliminating any loss due to leaks.

Because the larger portion of the gas consumed in this plant is purchased, and coke oven gas is a by-product, we have only limited ability to apply conservation measures in the production end of this utility. These gases are all used for producing heat by being burned in some type of burning equipment. How efficiently these gases are used is the job of the combustion engineer. He designs burning equipment and then applies combustion controls. A control system as applied to a block of soaking pits is pictured in Figure 13. From gas analyses, the fuel or combustion engineer establishes optimum conditions and then uses combustion control equipment to maintain these desired conditions. Only by the use of proper and reliable control equipment can gaseous fuels be conserved and consumed most economically. In our plant, the use of combustion control equipment is continuously increasing and the results are apparent by the gradual decrease in btu required per ton of product.

The operating procedures from Republic's Canton plant which are outlined above are several of many practices which have as their objectives the conservation of utilities.

Some of the equipment, but none of the ideas or procedures are new, and undoubtedly many other steel plants are working along similar lines.

The utilities conservation measures are reviewed here now because the time for the consideration of the savings made possible by such operations is most opportune and to bring such operating procedures as have been established in our plant to the attention of other steel plant personnel.

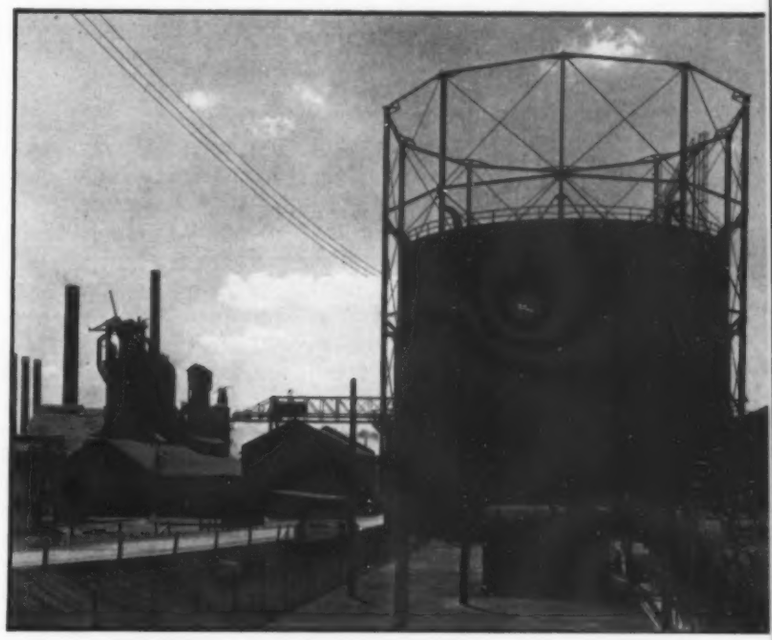


Figure 12 — Gas holder from which coke oven gas is dispatched.

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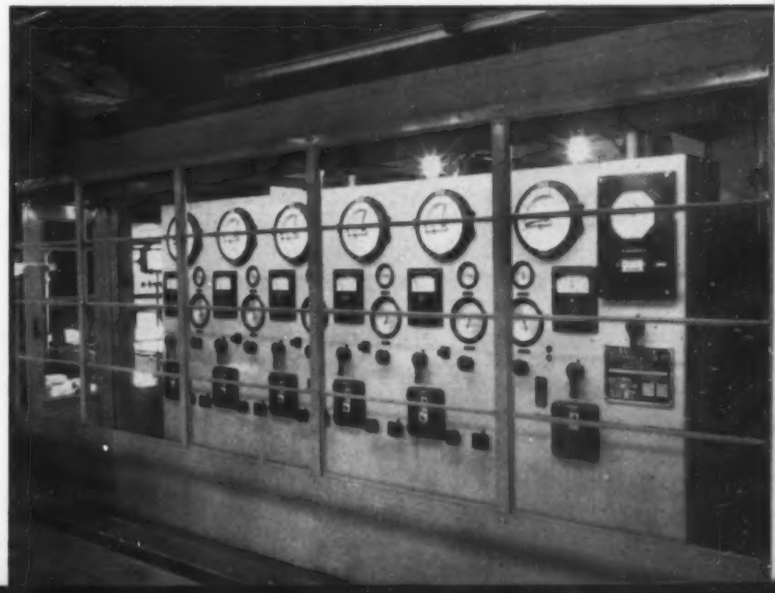
Figure 13 — Modern combustion control equipment on a soaking pit.



DISCUSSION

PRESENTED BY

L. S. STEINER, The Timken Roller Bearing Company, Canton, Ohio

P. L. WALTER, Superintendent of Mechanical Department, Republic Steel Corporation, Canton, Ohio

W. T. ADAMS, General Purchasing Agent, Republic Steel Corporation, Cleveland, Ohio

L. F. COFFIN, Superintendent, Mechanical Department, Bethlehem Steel Company, Sparrows Point, Maryland.

E. C. McDONALD, Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio

G. S. MONKS, Resident Engineer, Jones and Laughlin Steel Corporation, Cleveland, Ohio

W. G. HOOVER, Manufacturers' Representative, Pittsburgh, Pennsylvania

L. S. Steiner: I would like to ask if you find it economical to maintain a unity power factor on purchased power rather than a slightly lower value.

P. L. Walter: We have in our plant ample equipment for power factor correction.

L. S. Steiner: I understood it was generally considered uneconomical to attempt to maintain a power factor above 0.96 or 0.97.

P. L. Walter: It is economical with our particular equipment and contract with the power company.

W. T. Adams: I can answer that question. We were faced with the problem of providing power factor correction for the Canton plant, and after study of the job we decided that one 20,000 kva synchronous condenser was best suited to do the job. Then the war came along, and we found we were going to have at least twice as many electric furnaces to operate and we needed more correction equipment. The most economical thing to do was to duplicate the 20,000 machine that we had. With that 20,000, I think you can almost sing any tune the power company wants you to sing. Ordinarily, I think the answer would be that somewhere between 96 and 98 per cent is as good as one will ever need.

L. F. Coffin: Your water problems are very interesting. At Sparrows Point, we also are dependent to a certain extent on the artesian well water of the Baltimore industrial area. The water table has gone down to about 130 feet below ground level. As a result we have installed and have been operating for the past two and one-half years, a system whereby we reclaim sewage from the city of Baltimore to the extent of twenty-five million gallons a day, by coagulating with alum, clarifying and chlorinating. This water is used for roll cooling, and for other industrial purposes. In some cases, it is used over five times.

As I understand your situation, you have artesian wells and, as you say, a stream that is overflowing or very full at times. I would like to ask whether you have considered the possibility of recharging your underground strata during those times of full stream flow. I believe there are recharging type wells that are being developed for that purpose and while we had considered it at Sparrows Point, unfortunately the water supply we have available for that purpose is a little high in chlorides, and consequently we did not feel that it was adaptable.

Another point in connection with conservation of water that is frequently overlooked, is the cleanliness of the heat exchanger surfaces. For instance, we are now going through a campaign of chemically cleaning cooling surfaces of blast furnace stacks and hearths with the furnaces in operation, a process whereby the heat exchanger surfaces, including the internal surfaces of the copper blocks, are rendered clean. We are realizing what we should have realized long ago, that throughout the plant in many heat exchanger installations, cleanliness of surface will increase the efficiency of the equipment and also reduce water consumption because the water thereby can be used more efficiently.

P. L. Walter: In answer to Mr. Coffin's question, I question whether the laws of the state of Ohio would permit the recharging of wells. We have thought of it, but have never done anything along that line.

E. C. McDonald: Do you have much scale formation in pipes due to cooling water having a substantial rise in temperature, and if so, is it serious enough to cause short life of water cooled surfaces?

P. L. Walter: As brought out in the paper, most all of the cooling water delivered to the blast furnace and coke ovens is treated. The water that is raw, which is used in cooling, is principally used at the open hearths and electric furnaces. It is a composite of creek and well water, and we have had very little trouble from that source.

G. S. Monks: I would like to ask Mr. Walter what he does to clean up the creek water at the time of spring freshet, when the leaves and mud are in the creek.

P. L. Walter: Except for traveling screens and a settling basin ahead of the pumps, we have no special cleaning apparatus.

E. C. McDonald: A lot of mills reclaim water that has gone through a scale pit from rolling mills, and probably your plant does the same. Has it been your experience that the scale helps clean the water? It seems to be the opinion of many people that scale has a cleansing effect on water and I would like to have your opinion.

P. L. Walter: The water from our mills passes through sumps in which the scale is separated. We also have a series of baffles which separate the oil. We have had no particular trouble in reclaiming mill water, and the sumps are the only cleaning apparatus after our mills.

W. G. Hoover: May I ask approximately what would be the pH of the water after it has been run through this process?

W. T. Adams: You mean when it is finally discharged into the stream?

W. G. Hoover: No, I mean as it is taken into the mill for use, the pH of the water as conditioned for reuse and operation.

P. L. Walter: It is about 7.2 to 7.5.

THE FOREMAN'S RESPONSIBILITY for Safety

. . . . too often safety precautions were relaxed during the war . . . . now that the war is over, it is apropos to review the safety program . . . .

by J. L. Ridinger, SAFETY DIRECTOR
INLAND STEEL COMPANY
EAST CHICAGO, INDIANA

▲ UPON the entry of the United States into World War II, we were immediately confronted with a manpower shortage, which was augmented in part by the hiring of women, over-aged men and teen-aged boys. Then followed the period of material shortages, which was augmented by substitutes. All of these burdens and many others were placed upon the overburdened shoulders of the supervisor, the key man of management, and there was little wonder that at times his knees were seen to buckle under the load of his many mental burdens. As a result, many supervisors followed the line of least resistance, which in turn was responsible for a partial breakdown of proper working procedures.

One might ask at this point, if this were true how then were we able to produce the great quantities of war materials necessary to win the war. The answer is: our people had a sincere desire to win the war. Many of them had husbands, sons, or daughters at the front and wanted them to return home as soon as possible. Others worked unlimited hours for the opportunity of making more money.

Wars have been and always will be looked upon as a destructive force, which takes its toll of lives and leaves in its path, the dead, wounded and destitute. We think of them with fear, and sudder with horror as we visualize the means used by man to exterminate himself. Yet during the war years, within these United States, which were free of bombing attacks and enemy gun-fire, more people were killed and injured on the home front than at the battle front.

The National Safety Council reports that from December 7, 1941 to August 14, 1945, more than 261,000 members of the armed forces were killed. For the same period on the home front, 355,000 were killed.

These figures can be nothing less than startling, in spite of the fact that many plants went through the war period with excellent accident records.

Our immediate concern therefore is with the present and future prospects of the safety movement. The question occurs — what are we going to do about it? The answer is first, get back to practicing the fundamentals of safety, not only for industrial safety but for home and public safety as well.

All will agree that all plant managers want a good safety record. None of them want to be ridiculed by the people in their community as being negligent in the care of their employees.

But safety engineers know that good safety records are not the result of wishful thinking, on the contrary, they are the result of constructive action.

Management has to be just as diligent in creating a good workable safety program as they are in creating better production methods. As chemists, metallurgists

Presented before the American Society of Safety Engineers, Western Pennsylvania Chapter, Pittsburgh, Pennsylvania March 13, 1946.

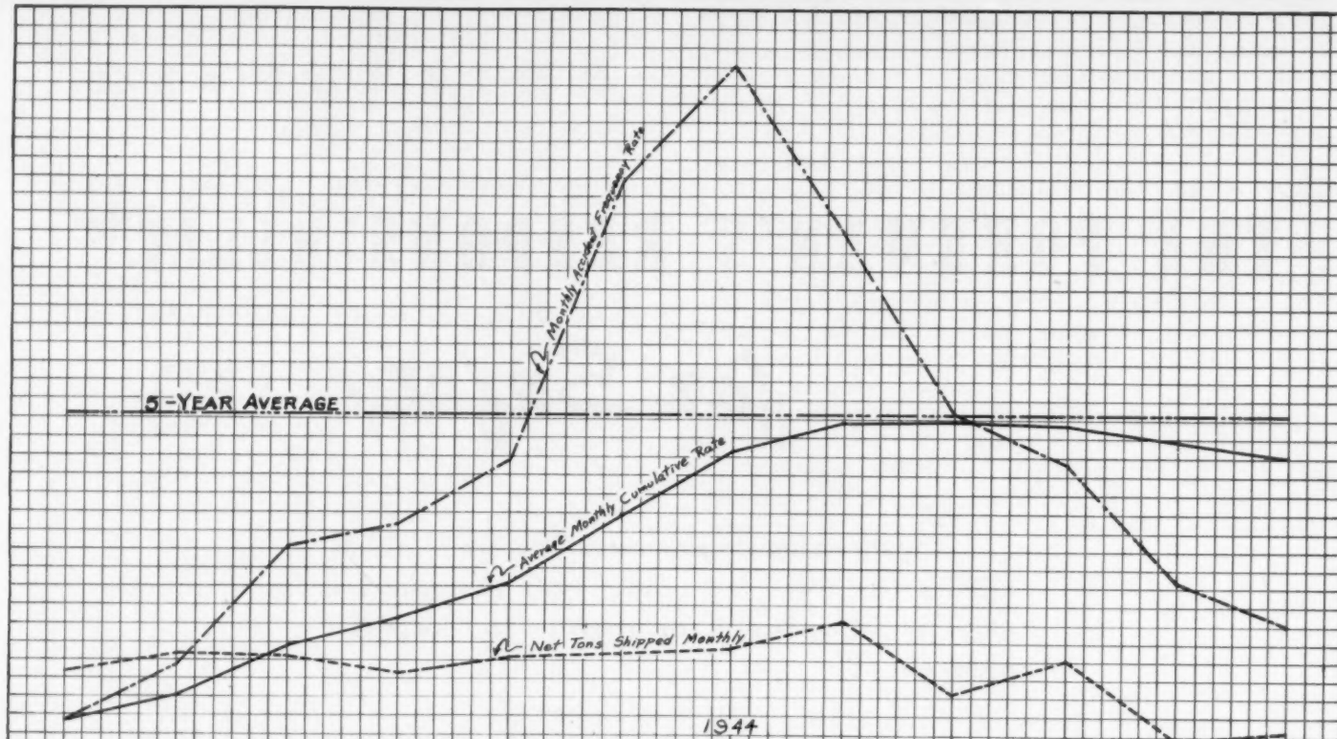


Figure 1 — Graphs showing how the present accident frequency rate compares with the five year average are used as a target to be bettered.

and draftsmen apply their skill for improvement, so must the safety engineer apply his skill to gain the co-operation of supervisors and workmen to reduce accidents.

Here are some of the things that every safety engineer can do to improve the safety performance of his plant.

1. *Plant housekeeping* — Labor shortages during the war years can be listed as the principle cause for poor housekeeping. This cause is being remedied gradually with mills resuming peacetime operations and by returning veterans bolstering the labor market. A clean plant is an essential part of any safety program. A dirty plant indicates a careless attitude toward safety, and contaminates the minds of new and old employees. A general plant clean-up and paint-up program should rate number one position on all post war safety programs.

2. *Mechanical safeguards* — Have you made a thorough inspection of your mechanical safeguards since the war? If you have not, I am sure you are in for a few surprises. You will find many guards worn out and several temporary guards, made during the war still in place. It is hard to convince workmen that management has a sincere interest in safety with a poorly guarded shop.

3. *Safety rules and job procedures* — You may still have your pre-war safety rules and job procedures in written form, but are they being followed and enforced? Labor shortages and production schedules during the war made a lot of Dr. Jekylls and Mr. Hydes out of foremen. It is very important and timely for supervisors and workmen to have a meeting of the minds on safety, for this is the beginning of a new era for safety. Production and safety shortcuts practiced during the war must be forgotten and eliminated. A program of severe discipline is not the immediate answer. The best approach to use in solving this problem is as follows: Have your supervisors use the time allotted for group safety meetings for reviewing safety rules and job procedures. Perhaps some changes are necessary. If so make them. These meetings will do two things. First they will serve as a refresher course for supervisors and men. Second, they will make for a common understanding between supervisors and men and a new basis for an enforcement program.

4. *Safety apparel and equipment* — There will be no better time than the present to check and inspect safety apparel and equipment. Review your stores stock list, then follow up by taking an inventory in each department. War substitutes, if found to be unsatisfactory should be discarded. Check employees to see that recommended safety apparel is worn.

5. *Safety education program* — What educational assistance is the safety engineer giving to the supervisor? The supervisor like the safety engineer is always looking for ways and means of stimulating his safety program. Foremen are interested in receiving safety bulletins weekly or monthly. Photographic stories of accidents are of interest to both the supervisor and worker. Slide study meetings of plant accidents increase interest in group safety meetings. If you have a house organ you can bring plant safety to the home

of the worker, by using picture stories of accident causes.

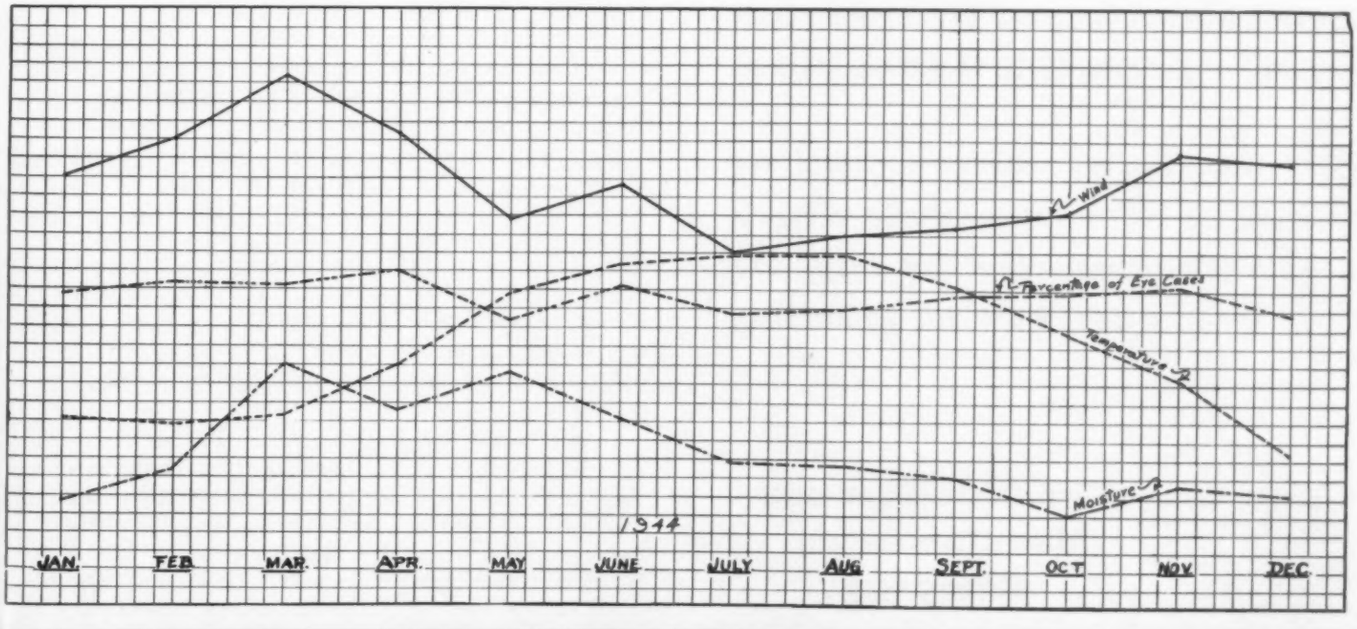
6. *Induction program for new employees* — The safety engineer can help prepare the new employee for his job. After the prospective employee is examined and hired he can be better prepared for his new job by attending an induction class at the industrial relations office. All new employees should be hired to work their first turn on the day turn. The purpose of the induction class is to familiarize the new employee with company policy. The new employee is checked for proper working apparel, safety shoes, gloves and lunch. After the class is over the new employee is delivered to his foreman's office.

7. *Induction program for new foremen* — Workers who are promoted to the rank of a supervisor, can better understand their safety responsibilities, if before they are placed on the job as a supervisor they are sent to the safety director's office and receive a policy talk relative to the foreman's responsibility for safety.

8. *Accident investigations* — There are two types of accidents, those that cause personal injury and those not involving injury, both are equally important from the standpoint of investigation. Too often, only those cases involving a disabling injury are investigated. Frequently minor injury causes warrant a more thorough investigation than disabling injuries. Supervisors should be required to investigate and submit reports on all types of injuries. In cases where an accident causes a disabling injury, we find it helpful to have two investigations. One immediately after the accident occurs and one when the injured employee returns to work. The second investigation serves to check the recommendations of the first investigation. Accidents not involving an injury and frequently called "close calls" are often passed off as trade risks. Investigation may or may not be held depending on whether or not the accident has caused material damage or a mill delay. The non-injury accident is the type the safety engineer hears the least about. However, there is one way in which a safety engineer can be informed about this type of accident. Make arrangements with your management to receive a copy of all damage reports.

9. *Accident statistics* — The safety engineer spends considerable time and effort in compiling accident statistics. The job can be overdone if more statistics are compiled than used. At Inland, accidents are compiled on a total frequency basis, which includes all injuries, disabling and non-disabling, such as eye cases, cuts, scratches and bruises. Supervisors are required to make out an accident report for every industrial injury reporting to the plant hospital. A five year total frequency normal has been set up for the plant. Each department and division works against a five year normal as illustrated in Figure 1. Each month, a report is sent to every divisional foremen which tells him what his total frequency was for the month and what his cumulative frequency is to date compared with his five year normal. Once a month, meetings are held with foremen showing the greatest increase in frequency over their five year normal. The meetings are conducted by the assistant superintendent of the department with a safety staff man present. Injuries occuring to men under foreman's supervision are discussed and analyzed. These meetings are called study meetings and their purpose is to assist the foremen to improve the safety performance of their men. We attempt to create a competitive interest between foremen on different turns in the same division but not competition between divisions or departments. The foreman competes with his previous record and the records made by his co-divisional foremen. In checking our total frequency figures during the past five years we have observed an interesting phenomena. On the basis of full operations we have approximately the same number of injuries in January as we have in December. There is a gradual rise in frequency through July, then accidents decrease almost in the same degree

Figure 2 — Frequency of eye injuries plotted against Weather Bureau reports.



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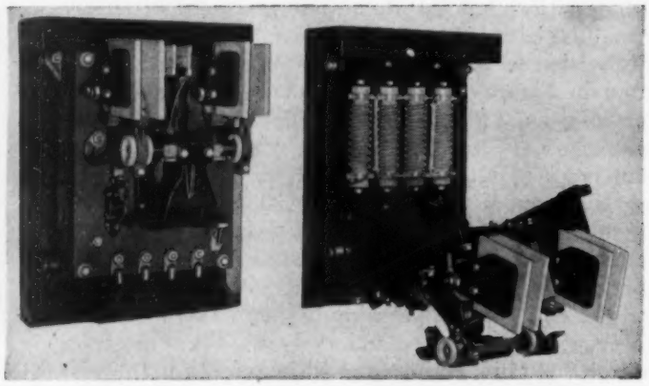

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as they increased and this is also shown in Figure 1, which is definite proof that weather conditions must be considered in every accident prevention program. Another study we have made which is of interest is that eye cases (dust in eye) are not seasonal, see Figure 2, as many supervisors will lead you to believe. We checked our dust in the eye cases for 1944 and 1945 against Weather Bureau reports, to determine if most of our eye cases occurred during the summer months. In 1944 we found that we had the fewest number in May and the greatest number in February. In 1945 we found we had the fewest number in February and the greatest number in October.

10 *Accident costs* — Every supervisor is interested in operating costs. He can be impressed with accident costs if they are properly presented. I have found that they question the formula that the average cost per accident is four times the direct cost. We present cost figures to them in the following manner. Compensation and medical costs per injury are added together. Medical costs include all charges for hospital and doctor bills and artificial appliances. Cost per injury for the previous year is multiplied by the total frequency rate to inform the supervisor what the cost is, in his department per million man-hours worked. The same formula is used for the current year to show the expected cost per million man-hours worked. It is important to caution the supervisor about his use of accident cost figures. It is my opinion that very little could be gained by a supervisor lamenting about his accident cost to his men. The average workman is not concerned about what accidents cost management unless the figures are ridiculously high.

11. *Union safety activities* — Unions can be helpful in reducing industrial accidents. We have had a Union Safety Council at Inland since 1942. The lodge elects a representative for each group. The representative in turn appoints an alternate and assistants for the various divisions within his group. Monthly meetings are held each month in the various departments to review and act upon suggestions made by union representatives. However, unions like management find it necessary to be vigilant in creating enthusiasm to keep their representatives actively engaged in safety work.

12. *Enforcement of safety rules and regulations* — Supervisors should have a friendly but firm attitude for all matters pertaining to safety. As mentioned earlier, supervisors and men must have a common understanding as to what is right and what is wrong. Proper training is necessary before this can be accomplished. It is my belief that there is no better way for the supervisor to obtain the good will and respect of his men than by demonstrating a sincere interest in the safety and welfare of his men. Written warnings and reprimands are an important part of an enforcement program but they should be used judiciously to avoid grievances.

In conclusion I wish to say, that supervisors must have super-vision. They must be trained to have a clear concept of their responsibilities. It is the safety engineer's job to teach and impress the men with the importance of safety. We can define safety as a continuous crusade against accidents. The right way of doing things must be told and retold and demonstrated and redemonstrated until safety becomes a habit.

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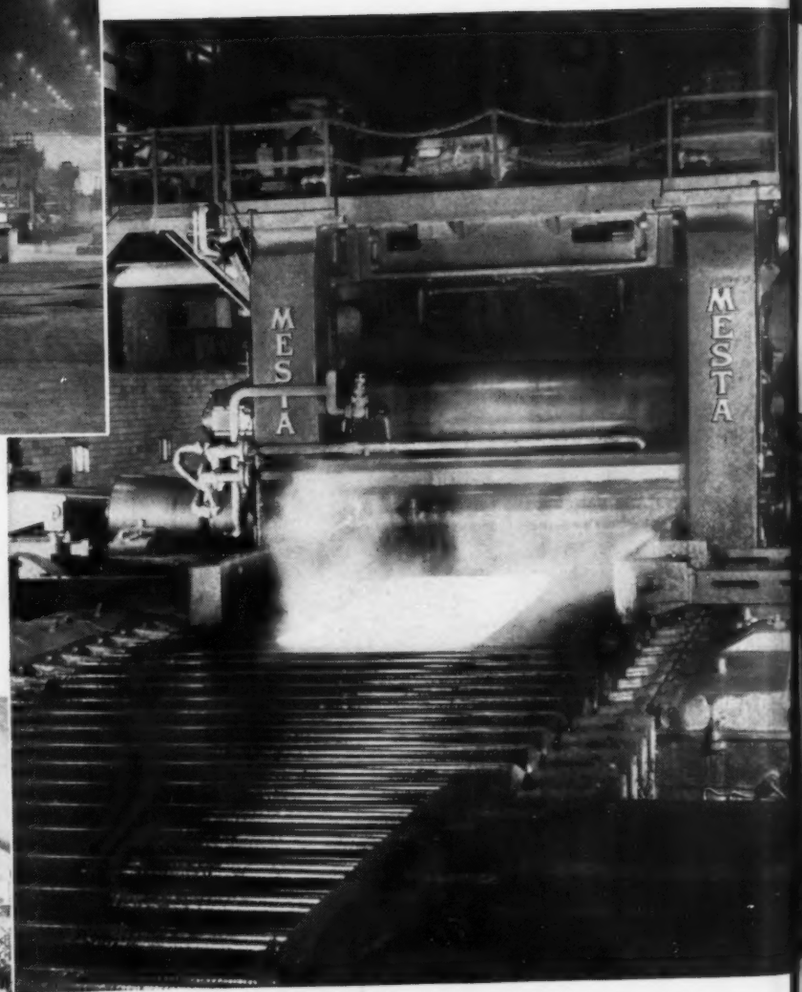

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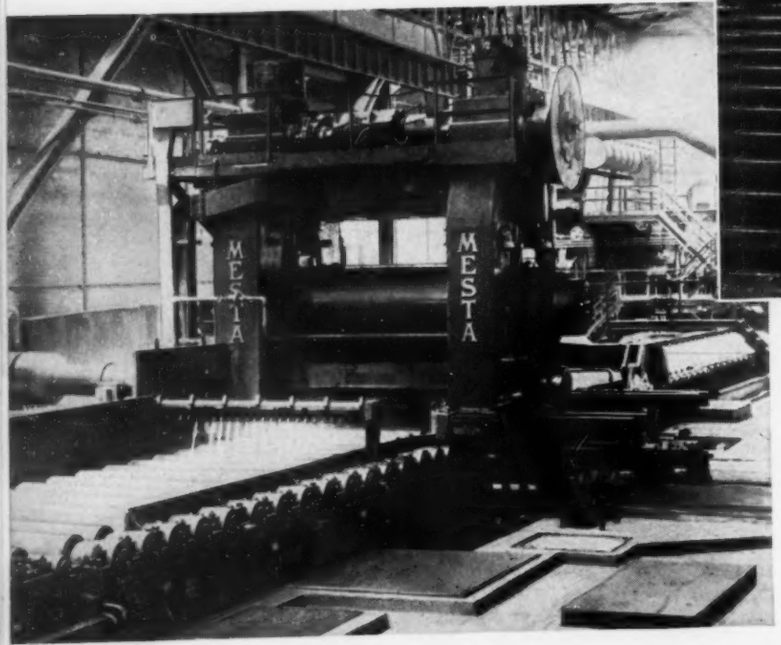

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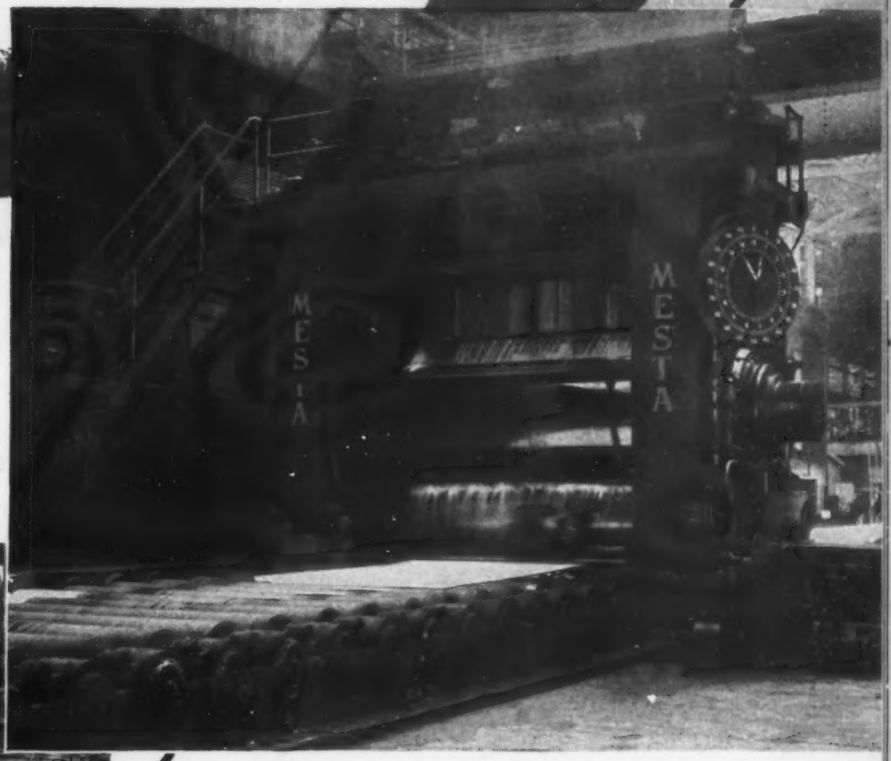

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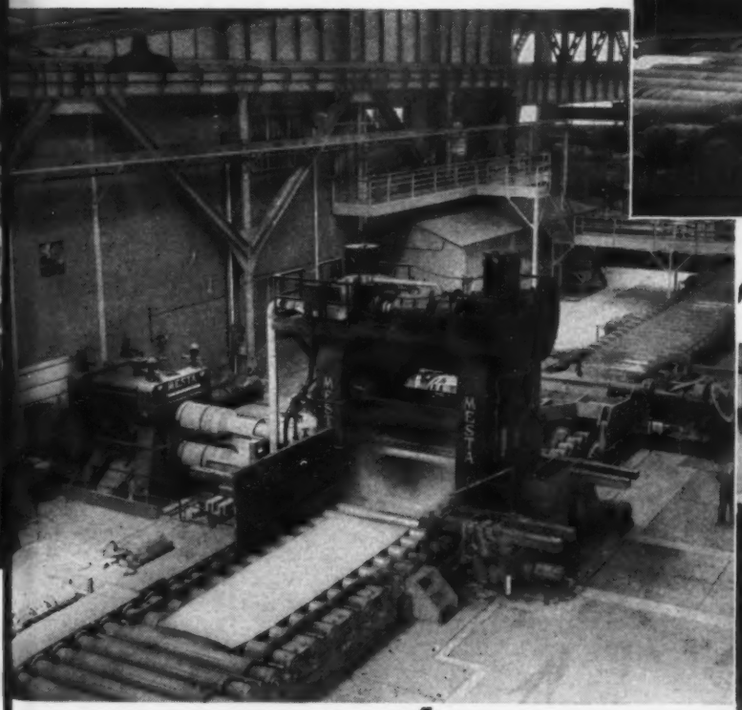

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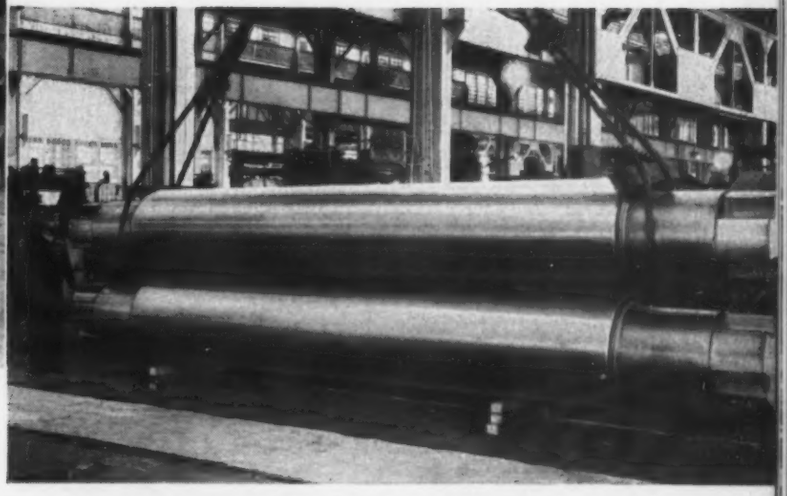

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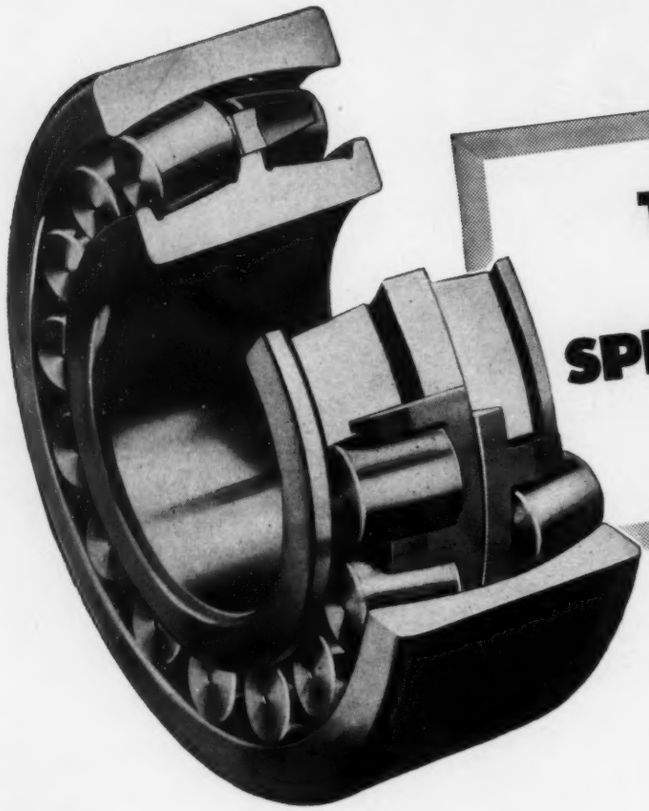

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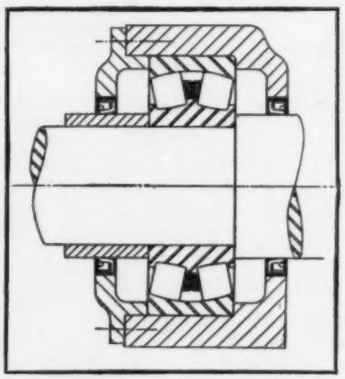

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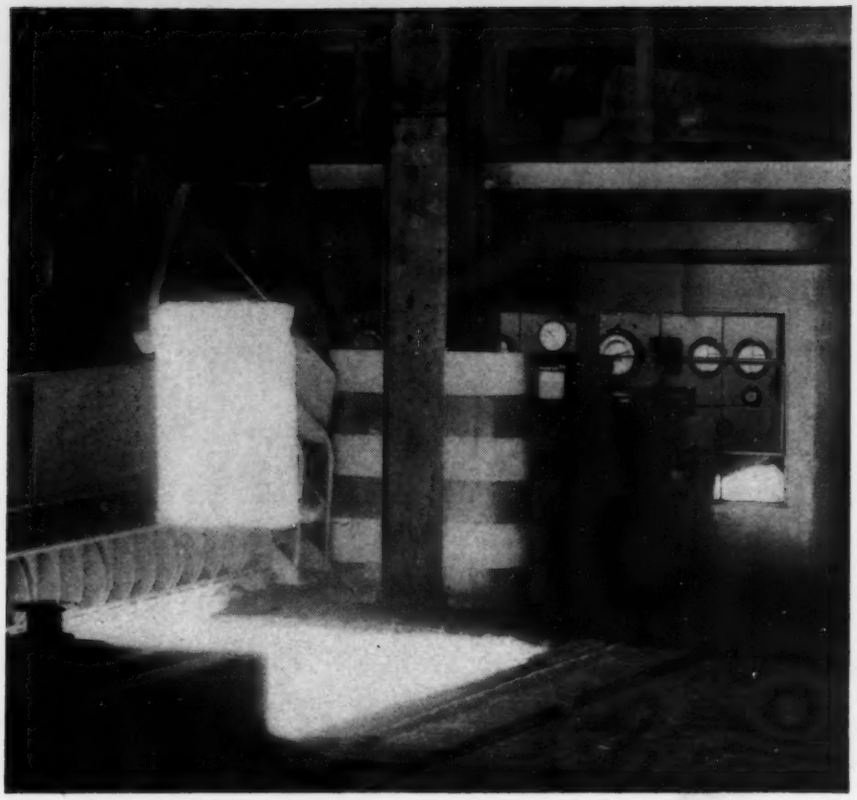

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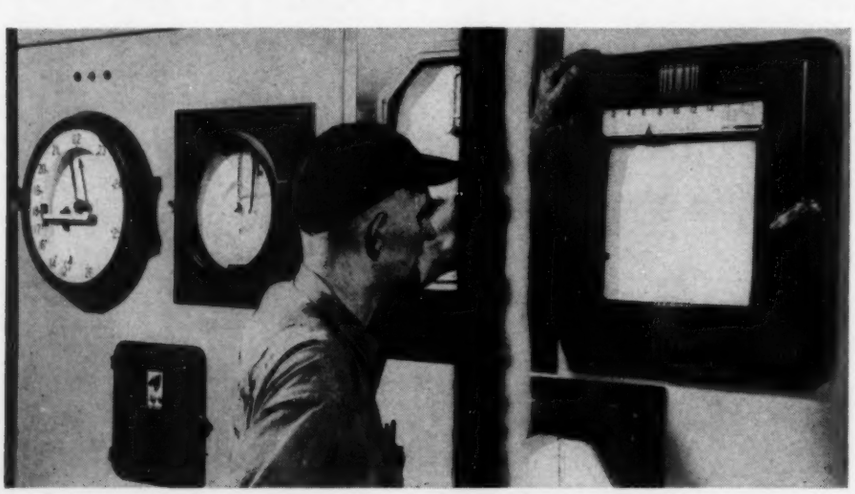

Control panel photographed through cubicle windows. Heater looks at Micromax Recorder for air and gas temperatures; behind him is Micromax Round-Chart Temperature Controller which regulates rate of heating.

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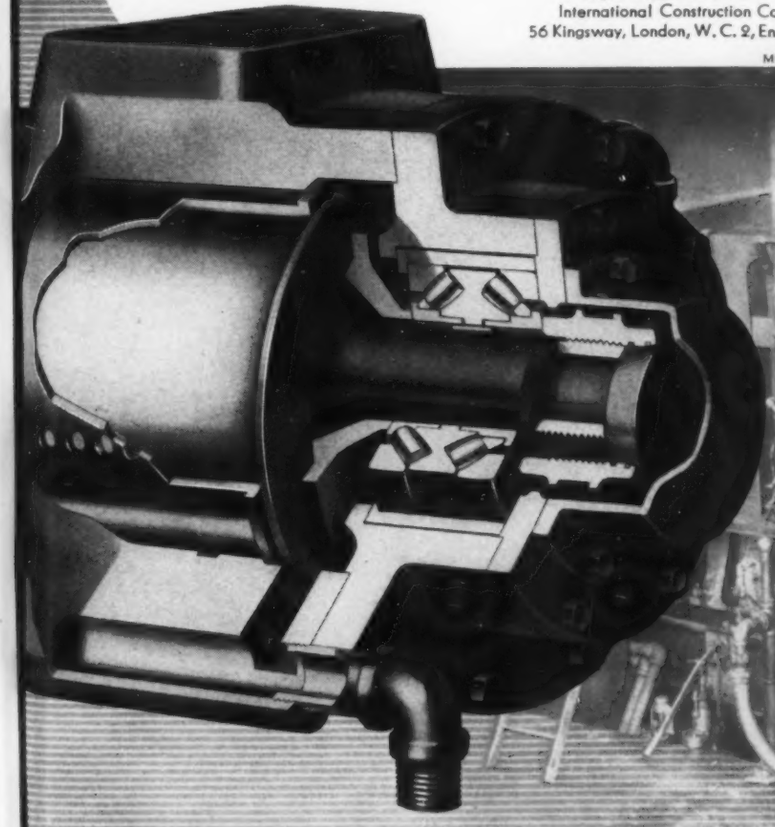

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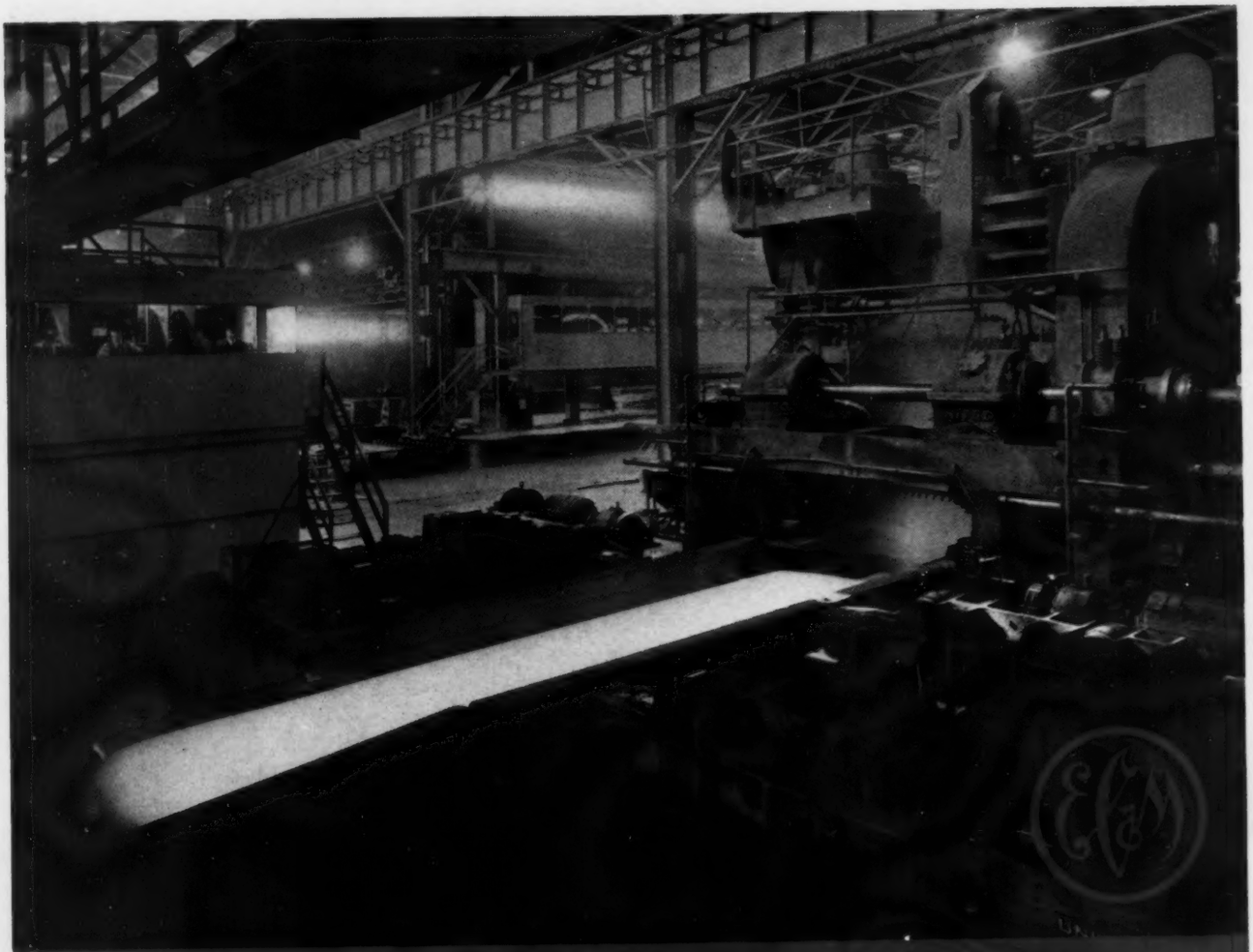

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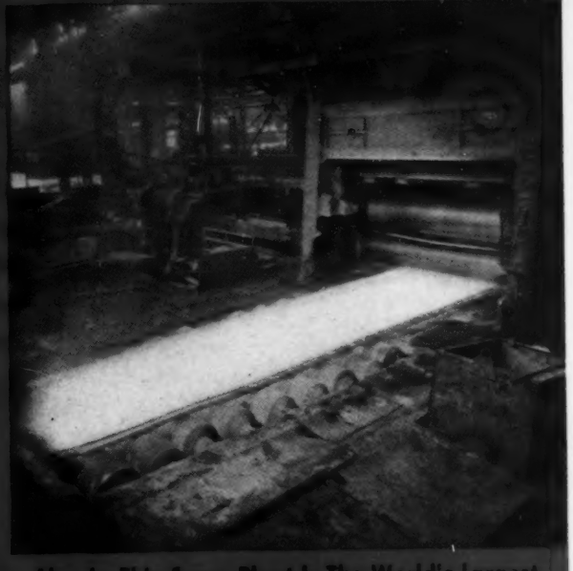

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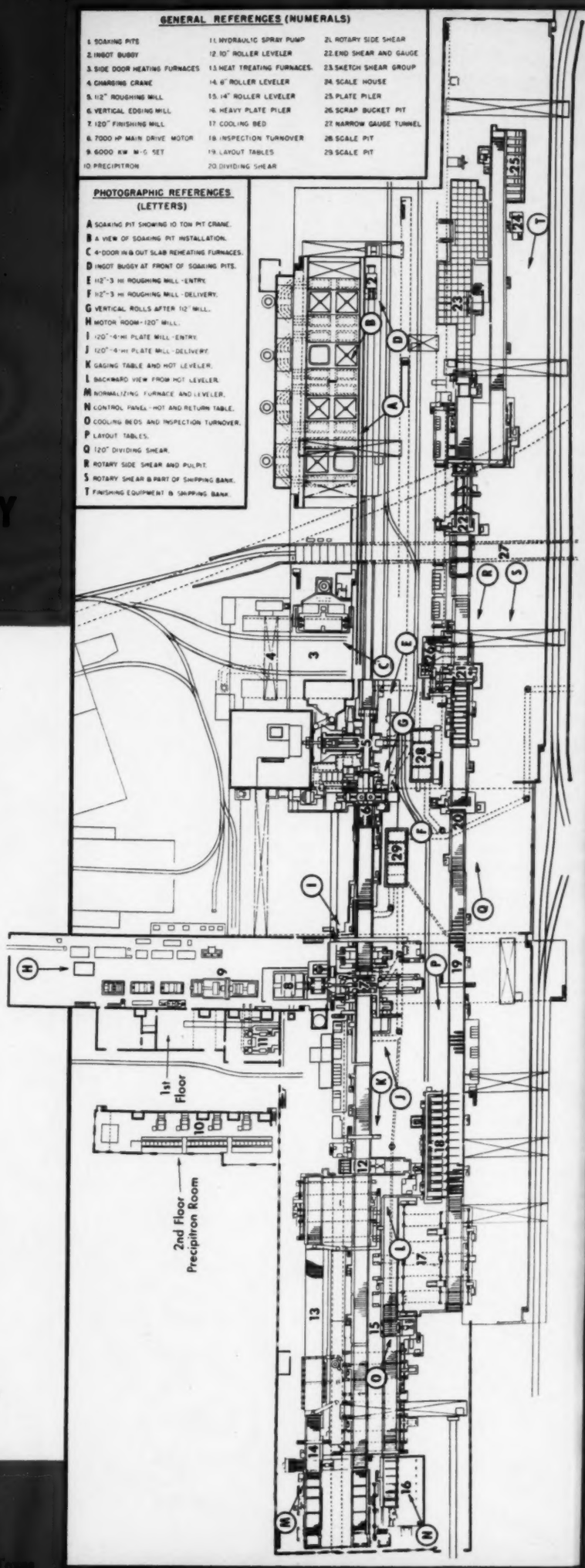
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3. SIDE DOOR HEATING FURNACES
4. CHARGING CRANE
5. 112" ROUGHING MILL
6. VERTICAL EDGING MILL
7. 120" FINISHING MILL
8. 7000 HP MAIN DRIVE MOTOR
9. 6000 KW M-G SET
10. PRECIPITRON
11. HYDRAULIC SPRAY PUMP
12. 10" ROLLER LEVELER
13. HEAT TREATING FURNACES
14. 8" ROLLER LEVELER
15. 14" ROLLER LEVELER
16. HEAVY PLATE PILER
17. COOLING BED
18. INSPECTION TURNOVER
19. LAYOUT TABLES
20. DIVIDING SHEAR
21. ROTARY SIDE SHEAR
22. END SHEAR AND GAUGE
23. SKETCH SHEAR GROUP
24. SCALE HOUSE
25. PLATE PILER
26. SCRAP BUCKET PIT
27. NARROW GAUGE TUNNEL
28. SCALE PIT
29. SCALE PIT
PHOTOGRAPHIC REFERENCES (LETTERS)
A SOAKING PIT SHOWING 10 TON PIT CRANE.
B A VIEW OF SOAKING PIT INSTALLATION.
C 4-DOOR IN & OUT SLAB REHEATING FURNACES.
D INGOT BUGGY AT FRONT OF SOAKING PITS.
E 112"-3 HI ROUGHING MILL - ENTRY.
F 112"-3 HI ROUGHING MILL - DELIVERY.
G VERTICAL ROLLS AFTER 112" MILL.
H MOTOR ROOM - 120" MILL.
I 120"-4 HI PLATE MILL - ENTRY.
J 120"-4 HI PLATE MILL - DELIVERY.
K GAGING TABLE AND HOT LEVELER.
L BACKWARD VIEW FROM HOT LEVELER.
M NORMALIZING FURNACE AND LEVELER.
N CONTROL PANEL - HOT AND RETURN TABLE.
O COOLING BEDS AND INSPECTION TURNOVER.
P LAYOUT TABLES.
Q 120" DIVIDING SHEAR.
R ROTARY SIDE SHEAR AND PULPIT.
S ROTARY SHEAR & PART OF SHIPPING BANK.
T FINISHING EQUIPMENT & SHIPPING BANK.
1st Floor
2nd Floor — Precipitron Room

THE diagram and photographs reproduced here show a typical example of McKee engineering in the Rolling Mill Industry.

McKee services include all phases of engineering and construction for Blast Furnaces, Open Hearth Plants, Rolling Mills and facilities for the preparation of raw materials.

The experience and specialized knowledge gained in four decades of engineering for most of America's steel companies and many foreign producers are available to you in this organization.

Arthur G. McKee & Company

★ *Engineers and Contractors* ★

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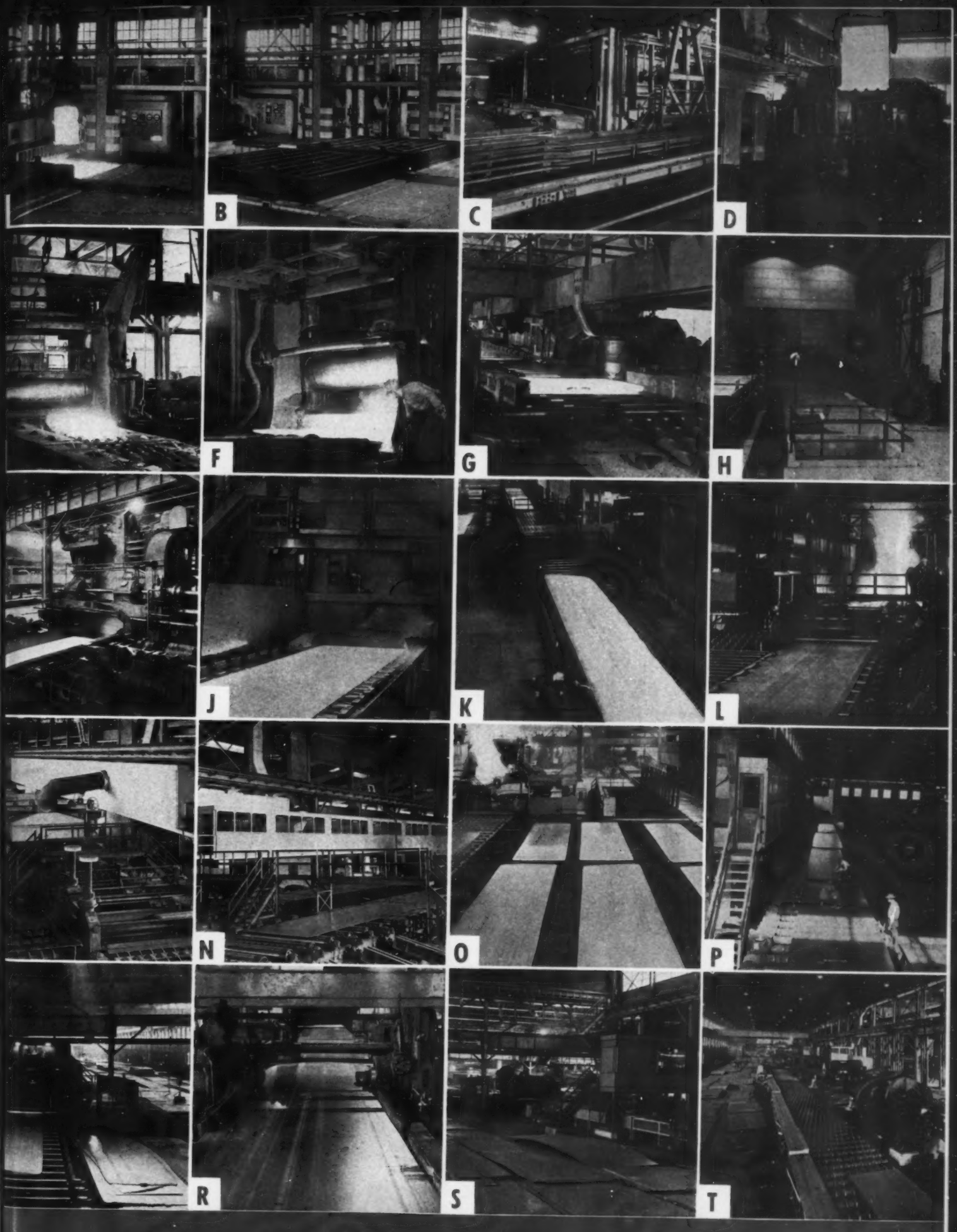
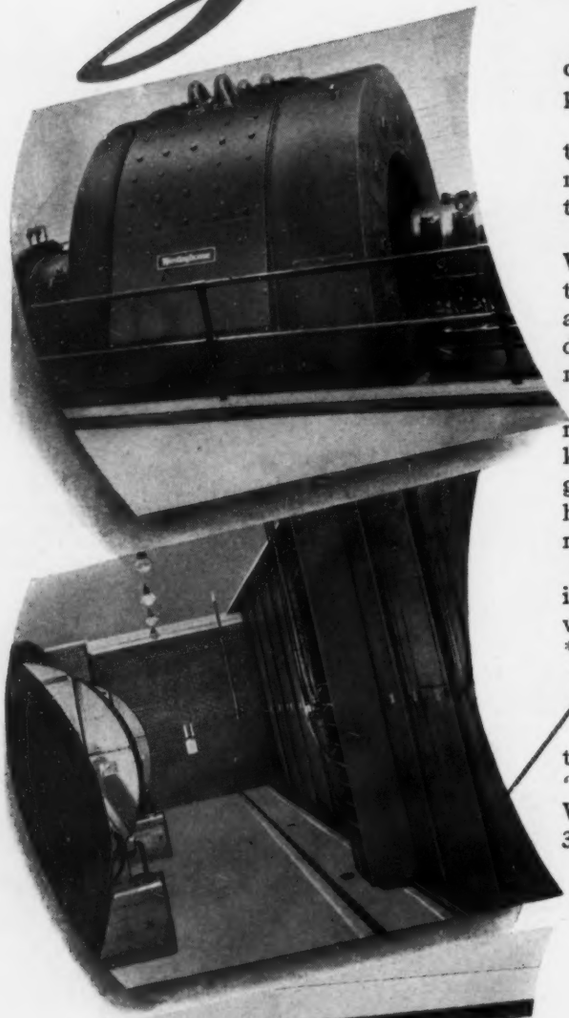


UNDIVIDED RESPONSIBILITY IN ONE ORGANIZATION

WESTINGHOUSE JOINS
IN TRIBUTE TO . . .

Lukens

a great mill with a great record



Westinghouse, having worked with Lukens Steel Company during the "arsenal of democracy" period, is particularly in a position to pay tribute to Lukens.

The newest plate mill at Lukens—built for increased production and greater accuracy in rolled steel plate—is a 120″ four-high mill. It *finishes* plate, previously roughed down on a 112″ three-high mill.

The 120″ mill rolls are driven by a 7,000-hp, 35/70-rpm Westinghouse reversing motor—one of the largest single-armature reversing motors built in this country. Air is introduced and withdrawn at each end of this motor, by a unique down-draft system of ventilation, making it possible to design for minimum WR^2.

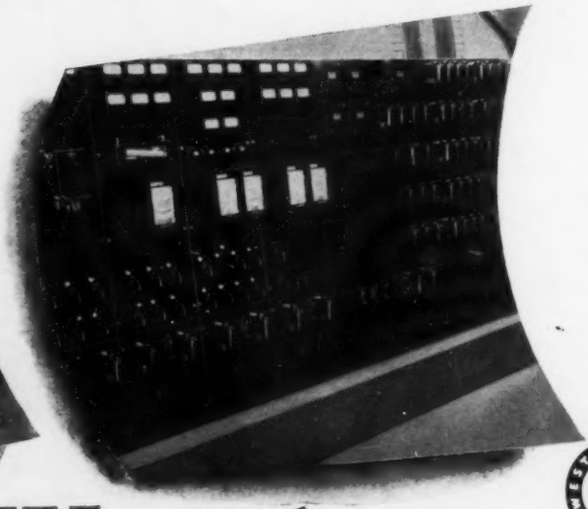
Edging rolls are driven by a Westinghouse 500-hp, 200/500-rpm reversing motor. Power is supplied by a Westinghouse 6,000-kw flywheel motor generator set with three 2,000-kw, 505-rpm generators, an 85,000-lb., 14-ft. diameter flywheel and a 6,000-hp, 13,200-volt induction motor. A Westinghouse liquid slip regulator and variable voltage control system is used.

The motor room is ventilated by a down-draft, non-recirculating system with *Precipitron—electronically-operated air cleaner, which removes 90% of all air-borne dirt. This is the first time a *Precipitron has been used in an all fresh air system of this type.

* * *

The Lukens' record speaks for itself. It is a source of satisfaction to Westinghouse to have shared in this record, with an *"assist"*—as an electrical partner of Lukens at Coatesville, Pa. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-94726

*Registered Trade-mark.



★ MUCH OF ITS ELECTRICAL EQUIPMENT BY **Westinghouse**

PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

For almost half a century UNITED has been identified with the latest practice and highest standards in design and construction of Rolling Mills and related apparatus. Pioneers of many "firsts" in steel making, UNITED'S engineers are singularly fitted, by experience and training, to deal intelligently with problems of the rolling industry.

Six large plants provide unparalleled production facilities.

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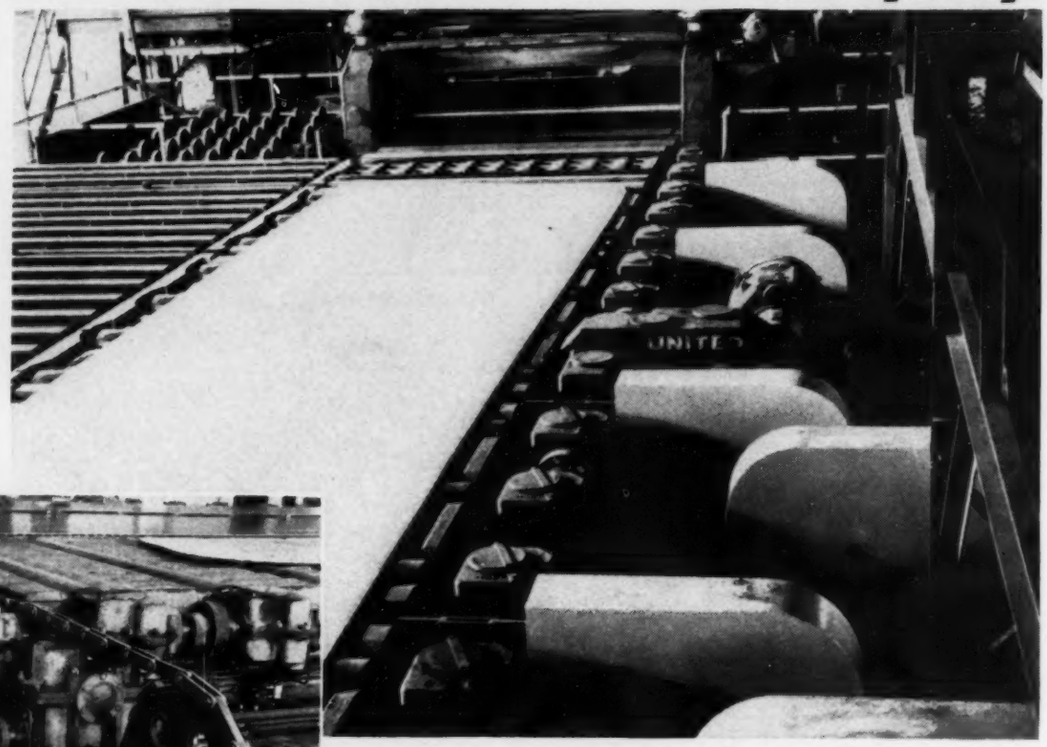
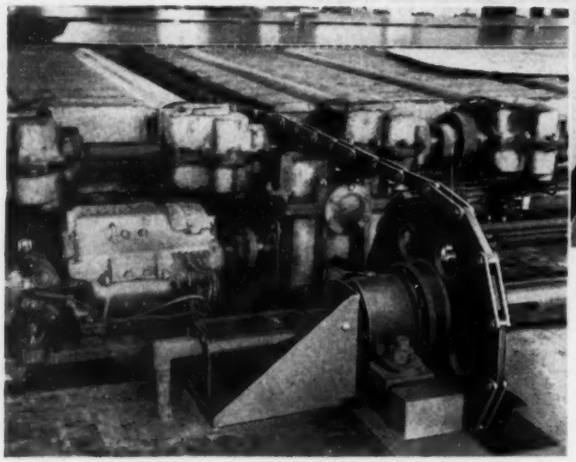
★ The World's Largest Designers and Makers of Rolls and Rolling Mill Equipment

LINK-BELT TRANSFER CONVEYORS
Give *Precision Handling in the 120" Plate Mill at Lukens Steel Company*

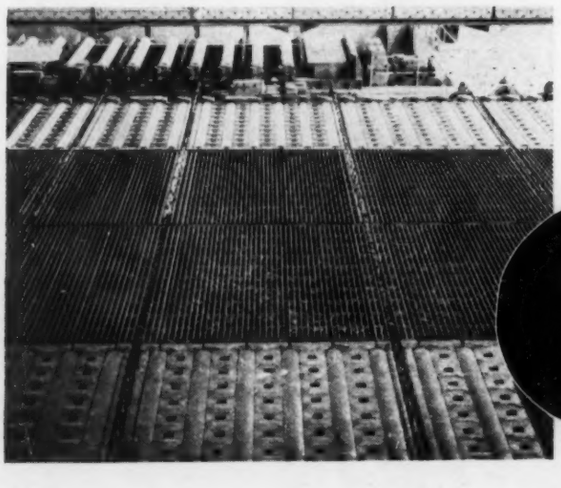


Pullover from cooling bed to leveller. Note precise alignment of plate edge with table.



Above—Transfer point where plate is removed from cooling bed to run-out tables by unloading conveyor.

Below—Transfer from one run-out table to another with provision for storage between Table No. 1 and Table No. 2.



For the new 120" Plate Mill at Lukens Steel Company, Coatesville, Pa., United Engineering and Foundry Co. selected Link-Belt Conveyors for handling plates in different stages of processing. Five are single units, the sixth is actually a combination of three units, as seen in the two smaller illustrations.

From broad experience in designing and building conveyors for every type of industry, Link-Belt engineers bring to current problems an unusual fund of knowledge, which, coupled with unsurpassed manufacturing facilities, assures their effective solution. Let Link-Belt conveyor and power transmission specialists aid you in making your operations more efficient—more economical.

LINK-BELT COMPANY

Chicago 9, Pittsburgh 19, Cleveland 13, Detroit 4, Indianapolis 6, St. Louis 1, Kansas City 6, Mo., Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8.
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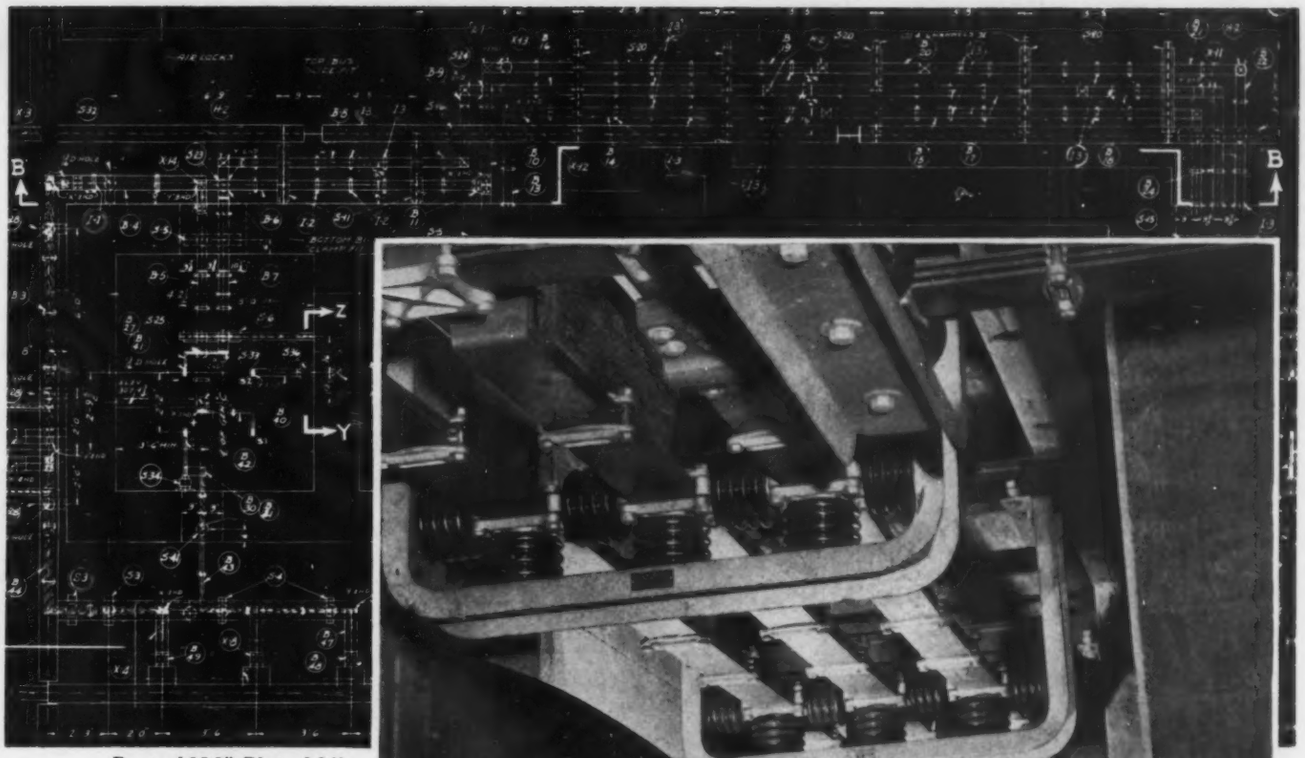
10,295

LINK-BELT CONVEYORS

PREPARATION EQUIPMENT . . . POWER TRANSMISSION MACHINERY



Part of 120" Plate Mill Main Bus Structure

Section of Bus Structure Between Generators

PROTECT AGAINST SHORT CIRCUIT DAMAGE

INSTALL DELTA-STAR REINFORCED BUS STRUCTURES FURNISHED COMPLETE FOR HEAVY DUTY MILL SERVICE

Bus structures must be able to withstand the terrific forces generated in the event of a short circuit. No present day circuit breaker is capable of opening within short enough time to protect the bus. Short circuits are disastrous when bus failures occur. By installing an adequately strong structure you reduce this hazard to a minimum.

On your next installation be protected. Install Delta-Star prefabricated reinforced bus structures designed and furnished complete to the last detail. Highest quality wet process porcelain, heavy steel frames and careful engineering assure a structure that will withstand the stress.

Delta-Star has been designing bus structures for heavy duty steel mill service in close cooperation with customers' engineers for over thirty years. Their long successful record is outstanding evidence why steel mill engineers prefer Delta-Star equipment.

Prefabricated bus structures are available for bar, tubing, structural or special shapes; indoor or outdoor service. *Ask For Publication 4504.*

DELTA-STAR ELECTRIC COMPANY

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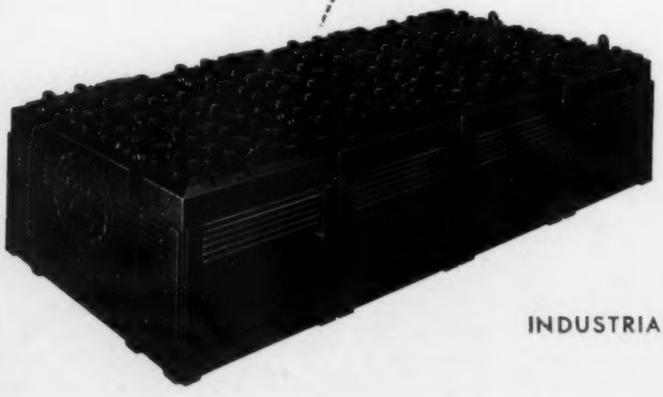
for low cost haulage!

● **ELECTRIC LOCOMOTIVE**
Philco equipped . . . used in the Open Hearth Department of Lukens Steel Company, Coatesville, Pa.

Many industrial plants are getting more work done at low cost from haulage equipment by specifying modern high capacity, long life Philco Storage Batteries. Latest development in top capacity motive power storage batteries is the sensational new Philco "Thirty", with 30% longer life. Here is a new cost-saving development which many users of battery-powered equipment are specifying for replacements and as initial equipment. Write for catalog of Philco "Thirty" specification data. PHILCO CORPORATION, Storage Battery Division, Trenton 7, New Jersey.



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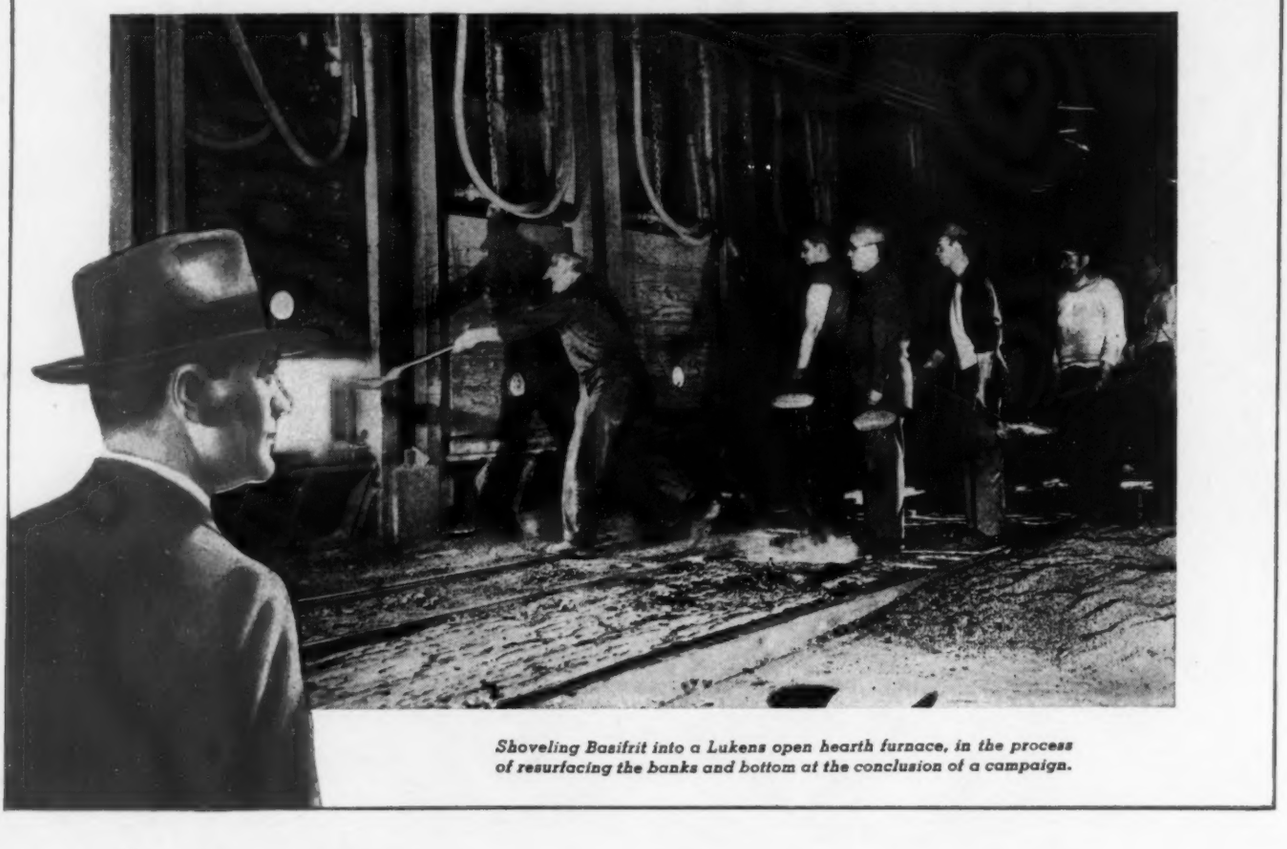

Shoveling Basifrit into a Lukens open hearth furnace, in the process of resurfacing the banks and bottom at the conclusion of a campaign.

HOW LUKENS CUT OPEN HEARTH DELAY TIME

IN the past three years, Lukens Steel Company, through a planned program, has appreciably reduced lost time in its Open Hearth Department. Its program for reducing delay time and lowering refractory costs has saved the company thousands of dollars.

Among other things it is now standard practice at Lukens, at the end of a campaign, to wash down the furnace hearth and then resurface with a refractory material which includes a quick-setting magnesite of the Basifrit-type. Thus each new campaign starts with a clean, solid bottom on which delay time is nil.

These fundamentals are followed in heat-to-heat maintenance: Banks and ends are made up as the heat goes into the ladle. Ends are kept high to insure complete bottom drainage. Very little spar is used. If a deep bottom hole develops, it is repaired with Hearth Patch. Thirty minutes are allowed for fettling and chilling the hearth before charging. Finally, systematic records are kept, to permit analysis of bottom delays, check results of procedures, and plot further improvement.

In working out its maintenance program, Lukens invited the suggestions of Basic Refractories Engineers, who welcomed such an opportunity to collaborate. The services of these men are always available for a discussion of refractory problems—and their practical recommendations are made without charge.

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Lukens -

PIONEER IN STEEL PLATES AND PLATE PRODUCTS

. . . . no company in the country has specialized as much in plate, plate specialties and plate products as the Lukens Steel Company and its subsidiaries . . . .

by T. J. Ess and I. E. Madsen

▲ WITH a proud record of growth and achievement stretching over the past 136 years, Lukens Steel Company and its subsidiaries, By-Products Steel Corporation and Lukenweld, Inc., all located on a 500 acre site on Brandywine Creek at Coatesville, Pennsylvania, and employing about 5000 individuals, present complete facilities for the production and forming of steel plate and for the design and manufacture of a wide variety of plate products and weldments.

Since 1810, when its activities consisted principally of the production of charcoal iron and the manufacture of plates for slitting into rods, Lukens has developed under a continuous line of family ownership and management. Established by Isaac Pennock and Jesse Kersey, and later taken over by Pennock's son-in-law, Dr. Charles Lukens, the company is probably the only steel producer that was actively run by a woman. Rebecca Pennock Lukens, widow of Dr. Charles Lukens, managed the company for twenty-nine years, during which time great progress was made. In 1854, Dr. Charles Huston, son-in-law of Rebecca Lukens assumed ownership and management of the business. Under his leadership, many improvements in the practices of plate production were adopted, including steam power, the three-high mill, the production of steel plate in place of iron, and various testing and inspection procedures.

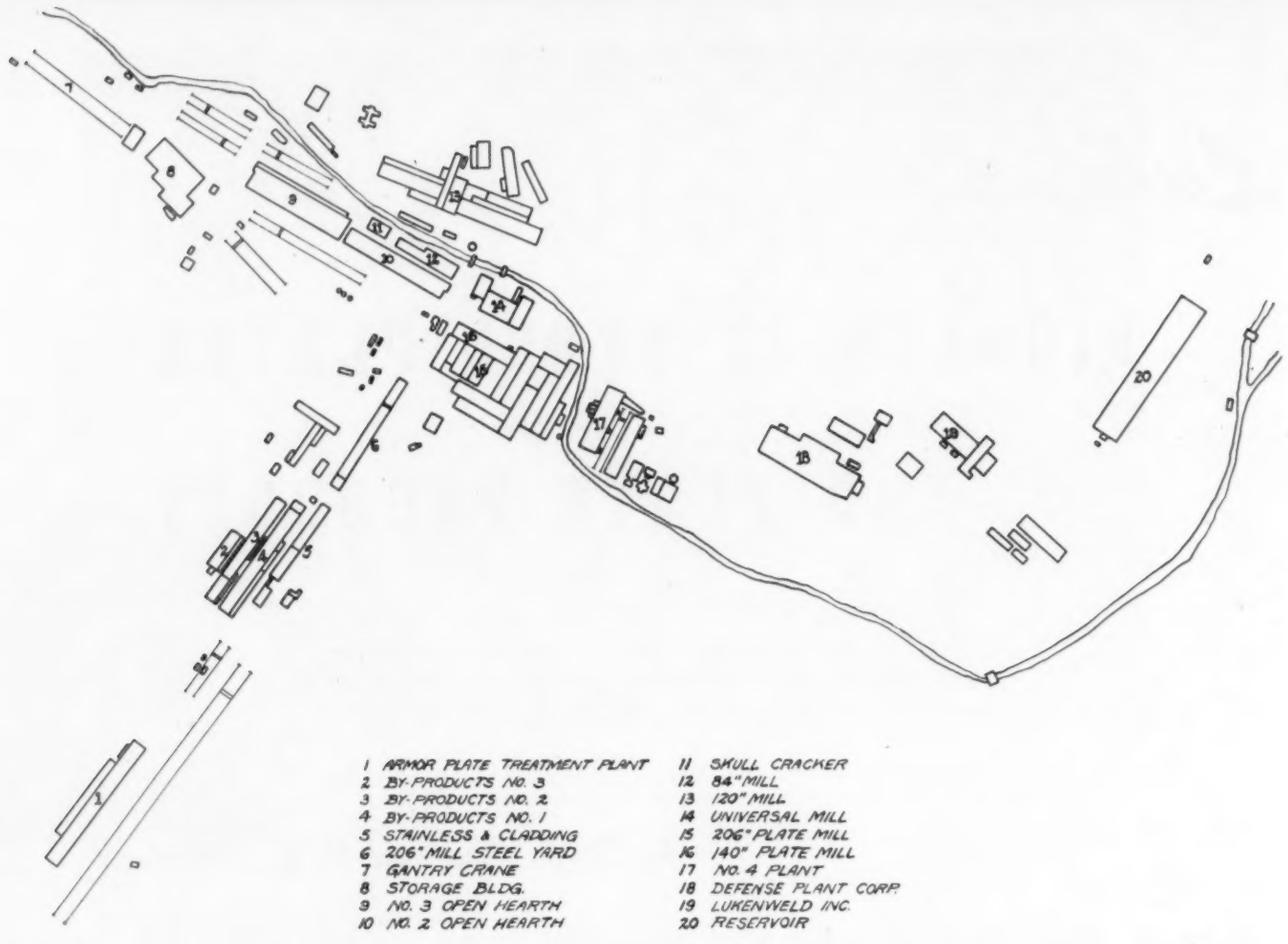
Upon the death of Dr. Huston in 1897, the management passed to his sons, A. F. Huston, who remained as president until 1925, and Charles Lukens Huston, who is still active as first vice president of the company.

The company was incorporated as Lukens Iron and Steel Company in 1890 and reincorporated in 1917 as Lukens Steel Company. By-Products Steel Corporation was founded in 1927 and Lukenweld, Inc. in 1930.

Present steel-making capacity of the company is 624,000 tons of ingots per year, which is a far cry from the 500 ton per year capacity of Rebecca Lukens' era.

Plates are produced ranging up to 25 in. in thickness, or up to 195 in. in width, practically all hot rolled direct from ingots, although some intermediate reheating is necessary for some products. Direct rolling is more applicable than the more conventional slabbing practice used in the majority of plants because there is no large scale production of constant sizes, but rather a jobbing schedule. Because of the direct rolling, ingots are bottom-poured in order to obtain satisfactory surface.

Today, Lukens is committed to the development of



Plan of Lukens Steel Company.

wider and more diversified uses for steel plates and steel plate products, with emphasis on the promotion of specialties. These include flanged products, steam platens, steel plate shapes and weldments.

A development engineering division has been established for the purpose primarily of developing new uses for steel plate in construction of machinery components and other types of equipment. In many cases, this is accomplished through redesign, and existing structures (often of cast iron or cast steel construction) are replaced by steel plate construction.

Lukens development engineering division, in collaboration with the engineering departments of producing companies, or independently, offers such service as: fundamental stress analyses of both statically and dynamically loaded structures; creative design of structures; machine design, and plant design.

OPEN HEARTH

Steel making facilities consist of twelve open hearth furnaces, divided between two separate shops. One shop contains five 90 ton basic furnaces and one 60 ton acid furnace, while the other shop contains six 125 ton basic furnaces. The 90 ton furnaces are 63 ft long overall, with a hearth 36 ft 6 in. × 13 ft 2 in., giving a hearth area of 480 sq ft. Bath depth is about 2 ft 4 in.

Uptakes 5 ft 9 in. × 3 ft 11½ in. lead to slag products 13 ft 2 in. × 12 ft 5 in. and 9 ft 7½ in. high, which are in turn connected to regenerator chambers 17 ft 8 in. × 18 ft 4½ in. and 16 ft 6 in. deep. Each chamber contains 3000 cu ft of checkers built up of 9 in. × 4½ in. × 3 in. fireclay brick.

The 125 ton furnaces are 69 ft 6 in. overall length, with hearth dimensions of 39 ft 8 in. × 15 ft giving a hearth area of 595 sq ft and a bath depth of 2 ft 6 in. Uptakes in these furnaces are 5 ft × 4 ft 10½ in., slag pockets are 10 ft 9 in. high and 15 ft 6 in. × 13 ft 6 in., and regenerator chambers are 20 ft 9 in. deep and 23 ft 10½ in. × 22 ft. A checker volume of 5000 cu ft constructed of 10½ in. × 4½ in. × 3 in. fireclay brick, is provided at each end of the furnace.

All furnaces have arched roofs, 12 in. thick with 15 in. ribs, of silica brick. Hearths are constructed with 2 in. of insulation, topped by a subhearth of rammed plastic 6 in. thick and by 8 in. of burnt in grain magnesite. Regenerator chambers are completely insulated, while the furnace itself has no insulation but is sprayed to reduce air infiltration.

Bunker C fuel oil, atomized by superheated steam, is used in all furnaces, with an average consumption of 5,600,000 Btu per net ton of ingots. Each furnace is equipped with automatic control for rate of oil flow and for furnace pressure, and with recorders on oil flow, steam and oil temperatures, furnace pressure, air flow and stack temperature. A four-point pyrometer shows checker temperatures.

Air for combustion comes from forced draft fans. Each furnace is equipped with a waste heat boiler and forced draft fan. Reversing valves are of water-cooled sliding damper type, entirely motor operated.

One shop which is 760 ft long × 110 ft wide, contains three 5 ton charging machines and two ladle cranes, one of 125 ton and one of 150 ton capacity. The other shop, 728 ft long × 156 ft wide, is provided with one 10 ton and two 5 ton chargers and two 150 ton ladle cranes.

Steel produced includes medium and low carbon grades and alloys, in rimming, semi-killed and killed types. Slab ingots, teemed by bottom-pouring, range from 18 in. × 8 in. × 56 in. to 90 in. × 40 in. × 123 in. Ingot weights run 1000-110,000 lb, the weights being obtained in many cases by pouring to different heights. An unusually wide range of ingot sizes is required in order to fit the jobbing schedules of the mills with the size of ingot best suited to produce the plate.

120 INCH MILL

Newest of the rolling facilities at Lukens is the 120 in. plate mill, which was financed by the United States Navy and placed in operation late in 1943. This new mill is so located that it can work in conjunction with a previously existing 112 in. mill which may be used as a rougher.

Rolling slabs or slab ingots 24-60 in. wide and 36-90 in. long, this mill produces plates ranging 22-110 in. in width, up to 1½ in. in thickness, and up to 80 ft long.

Heating facilities for this mill consist of four two-hole rows of recuperative pits and four side-door heating furnaces. The pits, 13 ft 6 in. long × 12 ft 6 in. wide × 10 ft 6 in. deep, are fired with natural gas through two burners, placed near the top of the pit in diagonally opposite corners. Standby burners and equipment for burning fuel oil are also installed. Waste gases leave the pits through ports near the bottom of the side walls and pass through refractory tile recuperators which heat the air required for combustion to temperatures averaging about 1200 F.

Each pit is provided with automatic controls for temperature, fuel-air ratio and furnace pressure, and with an individual fan rated at 6000 cfm at 6 in. water column pressure for combustion air. Fuel consumption averages about 1½ million Btu per ton.

Ingots are handled into and out of the pits by two 10-ton overhead pit cranes, while pit covers are handled by two cover mechanisms.

A detailed description of these pits ("Pit Furnaces at Lukens," by H. S. Hall) was published in IRON AND STEEL ENGINEER, October 1945.

Of the four side-door heating furnaces, three are of modern recuperative design, completely equipped with automatic control, while the fourth is a regenerative unit which will be modernized at its next rebuilding. These furnaces range 26-34 ft in length, 8-10 ft in width and 4 ft 8 in. — 6 ft 6 in. in height.

The side-door furnaces are also fired with natural gas and have auxiliary facilities for the use of fuel oil. Fuel consumption averages about 2½ million Btu per ton.

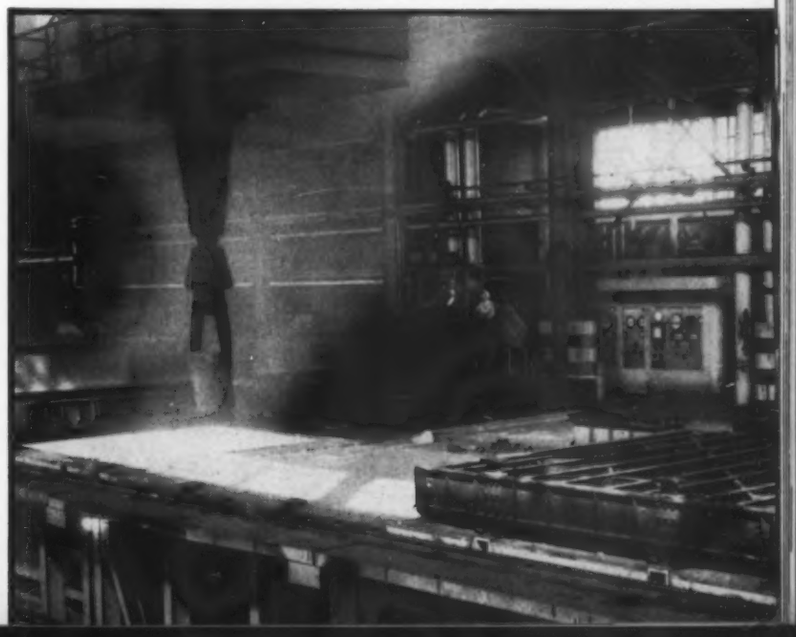
These furnaces are served by a 5-ton charging crane, which deposits heated steel from the furnaces directly upon the mill approach table. Steel from the soaking pits, however, is brought to the mill by a remote-controlled ingot buggy, which may also be used to carry breakdowns from the mill back to the pits for reheating.

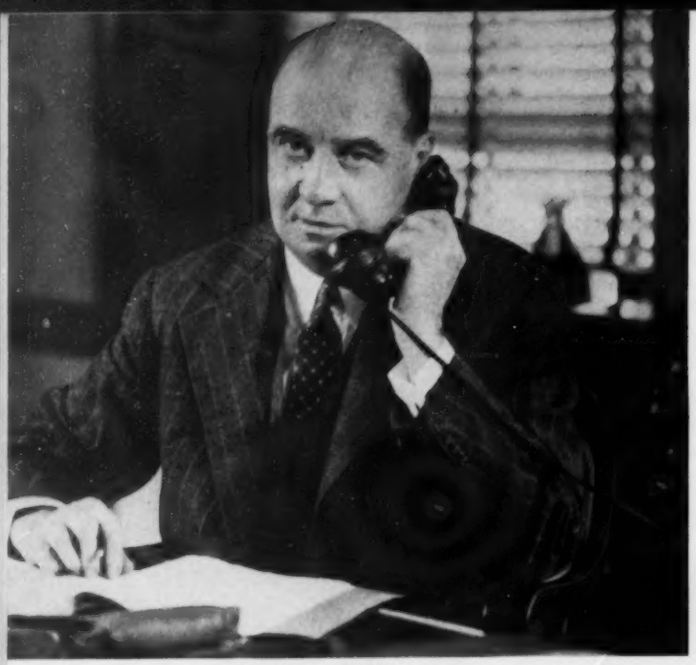
An approach table 24 ft long and a tilting mill table hydraulically operated and 21 ft 3 in. long, lead to the 112 in. three-high roughing stand. The rolls in this stand

Slab ingots are teemed by bottom pouring, so that plates may be rolled direct from ingots with satisfactory product surface.

▲

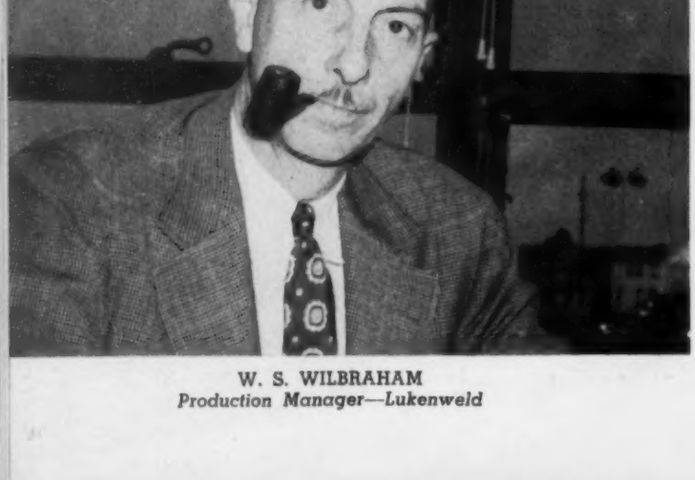
Eight recuperative pit furnaces, fired with natural gas, heat most of the ingots rolled in the 120 in. mill.





ROBERT W. WOLCOTT
President of Lukens, By-Products and Lukenweld

C. L. HUSTON, JR.
Executive Assistant to the President—Lukens



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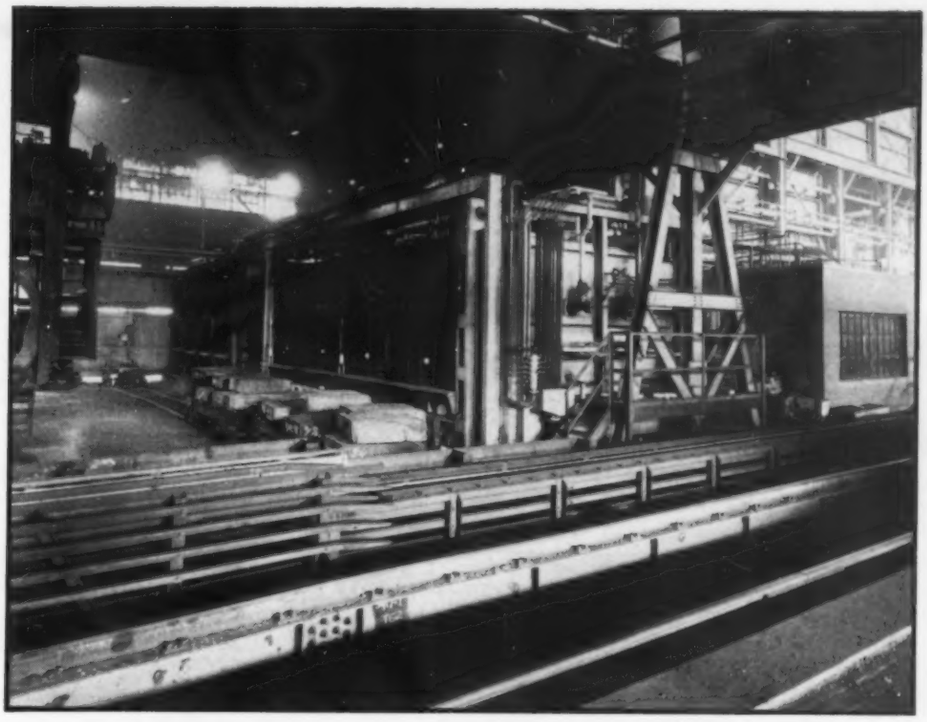
G. D. SPACKMAN
Vice-President, Operations—Lukens

L. M. CURTISS
General Manager, Steel Plants—Lukens

P. E. COPELAND
Assistant to General Manager of Steel Plants—Lukens



Four side door heating furnaces supplement the heating capacity provided by pit furnaces for the 120 in. mill.

have a body length of 112 in., the top and bottom rolls having a diameter of 36 in. and the middle roll a diameter of 21 in. Roll neck bearings are of bronze with forced feed lubrication. Rolls are hydraulically balanced and the middle roll is shifted hydraulically. A maximum roll lift of 17¾ in. may be obtained, the adjustment being effected by mill screws 11 in. in diameter with 1½ in. pitch and driven by two 50 hp motors.

The 112 in. mill is driven by an induction motor 3750 hp, 2200 v, 500 rpm which develops an operating torque of 39,300 foot pounds and a maximum torque of 98,250 foot pounds, driving through a gear reduction set of 5.61 to 1 reduction, giving a speed of 90 rpm to the leading spindle which drives through the mill pinions having a 1 to 2 ratio, which in turn gives a rolling speed of 425 feet per minute. The lead spindle 14 ft 7 in. long × 19½ in. in diameter connects to the pinion stand which contains herringbone pinions of 6.76 in. pitch and 36 in. face. Top and bottom pinions have 42½ in. pitch diameters, while the middle pinion is 21¼ in. in diameter. Mill spindles are 12 ft 1½ in. long × 20 in. diameter. Couplings are of the joggle type except the drive end of the lead spindle, which is pod type.

Following the roughing stand at a distance of about 40 ft is a vertical edger which contains rolls 42 in. in diameter and of 28½ in. face. These rolls operate in bronze bearings lubricated by a circulating oil system. A maximum roll opening of 120 in. is available. The main drive, operating through bevel and herringbone gearing, is a 1250 hp, 600 volt, 70-210 rpm d-c motor, giving a rolling speed of about 170-510 fpm. Power for this motor comes from a 1000 kw motor generator set located in the 120 in. mill motor room.

The edger acts to maintain uniform sides and reduce side scrap.

Located approximately 140 ft from the edging unit is the new mill, a four-high 36 in. and 54 in. × 120 in. unit with integral vertical edger. This mill is driven by a 7000 hp, 700 volt, 35-80 rpm d-c reversing motor capable of generating torques 1,050,000 lb ft rating, 2,890,000 lb ft maximum. Vertical rolls of 24 in. diameter and 10 in. face are driven by a 500 hp, 700 volt, 200-500 rpm d-c reversing motor. The vertical rolls are adjusted in a horizontal direction by two 25 hp motors.

A remote-controlled ingot buggy carries steel from the pit furnaces to the mill table.

Layout of 120 in. plate mill.

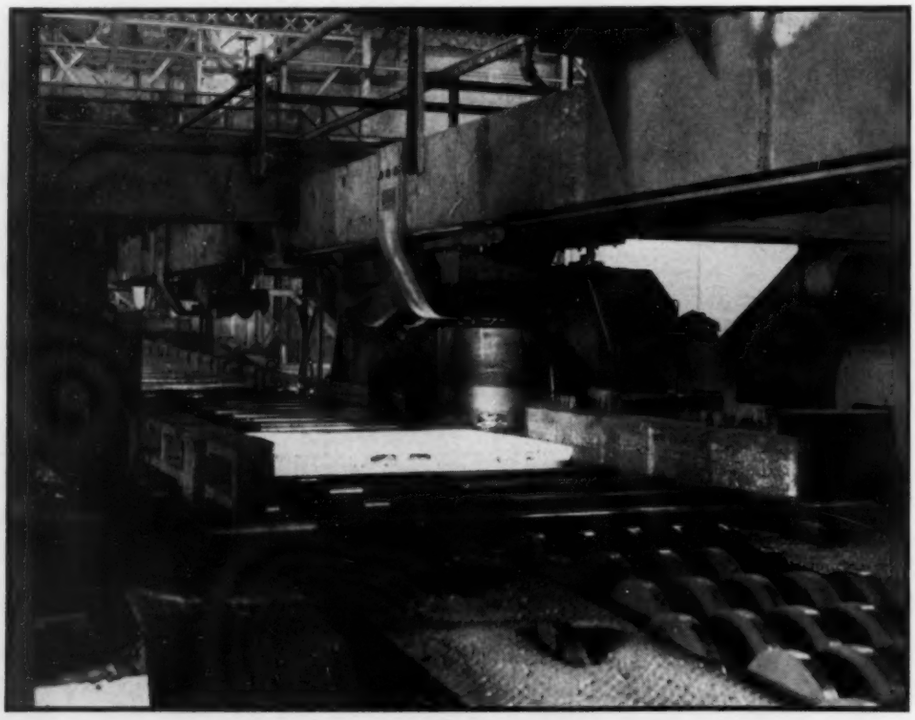
A maximum opening of 120 in. may be obtained. Rolling speed may be varied from 350 to 800 fpm.

Roller bearings are used for the necks of the work rolls in the mill and for the vertical edging rolls. Mill back-up rolls run in oil-flooded bearings.

The rolls in the 120 in. mill are balanced by an oil-hydraulic system. A maximum roll lift of 15 in. is available. Mill screws 20 in. in diameter and of 1 in. pitch, are operated at a lift speed of 12 in. per min by two 75 hp motors under variable voltage control which is automatically interlocked with other mill motions.

Under this control, the rolling schedule is set up on a switchboard by plugging cords into holes marked with the desired mill opening. It is possible to set up a rolling schedule with as many as 21 passes on this board, and there are two complete sets of plugs, allowing one schedule to be set up while the other is being rolled. In order to change from one schedule to the other, it is only necessary for the screwman to operate a small desk mounted pistol grip control switch. Actually, 5 to 9 passes are normally required, when finishing breakdowns from the 112 in. mill.

The automatic screwdown is interlocked with the front and back sideguards and the attached edger. With a slab in front of the mill, the front sideguards and attached edger are moved in to center the slab on the tables, and the back sideguards moved out to a position which will clear the piece when brought through the mill. The slab is then sent through the mill by operating the screwman's foot master switch controlling the speed



Between the 112 in. mill and the 120 in. mill is a separate vertical edger with 42 in. diameter rolls operating in bronze bearings.

and direction of the main drive, attached edger drive, and front and back tables. Upon reaching the back of the mill, the slab is stopped and the operator presses the automatic screwdown push-button located on the desk. The roll opening automatically changes to the preset value for the second pass, the back sideguards move in to center the piece and the attached edger and front sideguards move out to a position which will clear the piece when it comes through the mill. When the piece is in front of the mill and the screwdown button is pressed, the next pass opening is automatically reached, and the same action as above in the reverse direction takes place on the sideguards and edger. This automatic in-and-out stroke of the sideguards and edgers can be adjusted to any value between 0 and 5 inches.

The position of the screws on each side of the housings, each sideguard and each edging roll is indicated at all times by selsyn driven indicators on the screwman's desk.

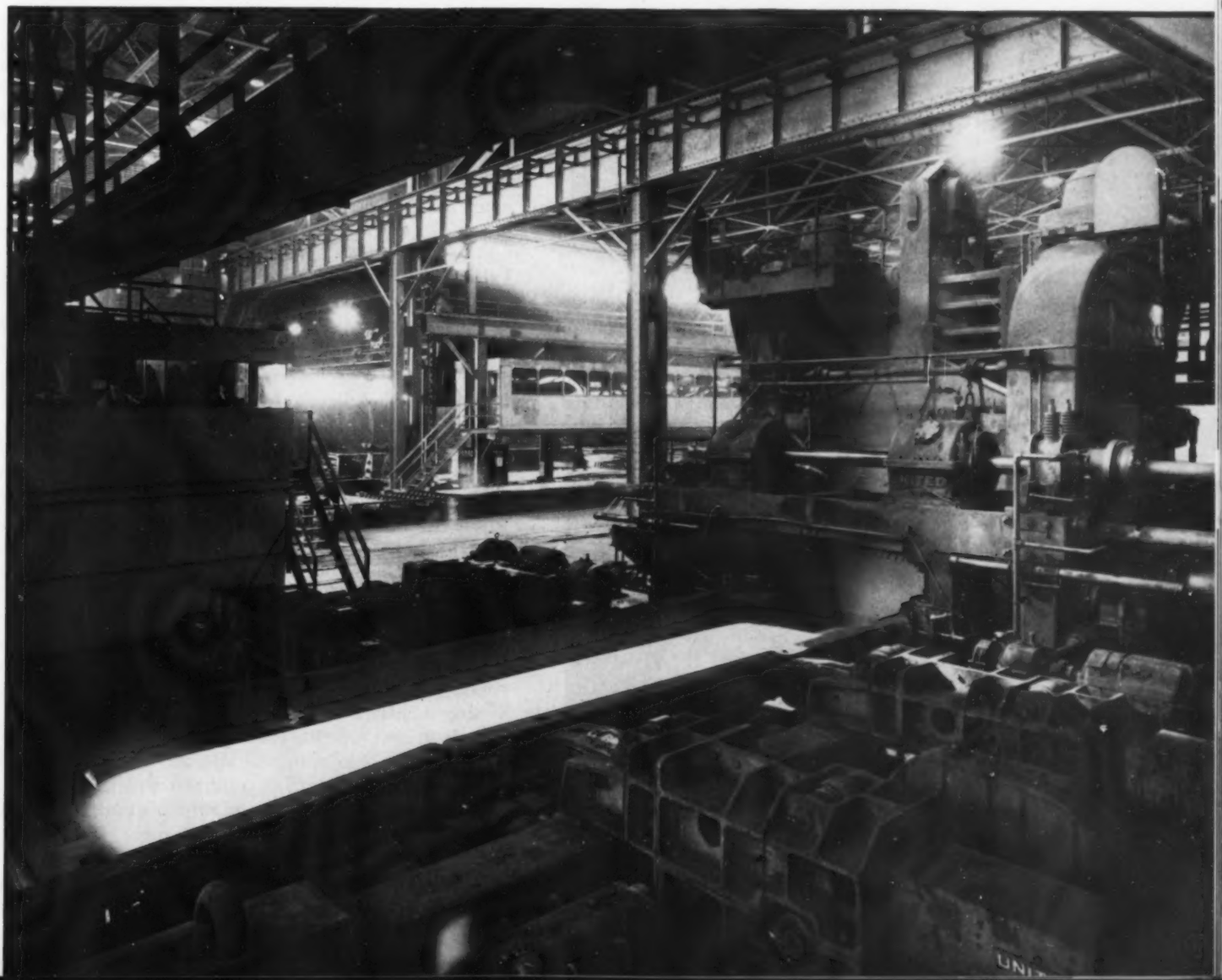
The automatic action will only take place with all of the manual controls for each motion in the "off" position. The screwman can at any time perform any motion manually by operating its respective controller.

Mill pinions of 4.522 in. pitch, 60 in. face and 39 in. pitch diameter are connected to the mill by universal spindles 15 ft 8½ in. long × 19½ in. diameter.

Mill tables, which, with the exception of the 112 in. mill tilting tables, are equipped with roller bearings, are driven through bevel gears and line shafts by mill type motors. Front and back mill tables on the 120 in. stand (each 52 ft 9 in. long) are operated under adjustable voltage control, with provision for draft compensation between front and back table speeds. Rollers are spaced on 3 ft centers.

Descaling is performed hydraulically by sprays located on the bottom of the front side and on the top of the back of the 112 in. breakdown mill. Both bottom and top sprays are located on the back of the 120 in. mill. Water pressure is maintained at 1300 psi by two 1000 gpm centrifugal pumps driven by 900 hp synchronous motors under automatic pressure control. A pneumatic accumulator, 4 ft × 40 ft, protects the system from extreme surges and swings. The removal of scale is greatly facilitated by the use of a spirally grooved or fluted middle row in the 112 in. roughing stand. Mill scale is flushed from underneath the mills and tables

The 120 in. mill, a four-high unit, is equipped with integral edger and with preset automatic control of screwdown, edger screws and side guards.



by 300 psi flushing jets into two scale pits, from where it is removed by clamshell bucket and overhead crane.

Adjacent to the 120 in. mill is its motor room, in which is housed the main roll drive motor, the motor driving the integral edging rolls, the required motor generator sets, exciters, control, switchgear, etc.

Power for the main roll and integral edger drives stems from a motor generator set consisting of three 2000 kw d-c generators driven at 509 rpm by a 6000 hp, 13,200 volt wound rotor induction motor, with a 100,000 lb, 162 in. diameter plate flywheel. The motor generator set feeding the separate vertical edger drive, previously mentioned, consists of a 1000 kw, 600 volt d-c generator driven by a 1450 hp, 2200 volt synchronous motor. Both of these units have their individual exciter sets and auxiliary exciter sets.

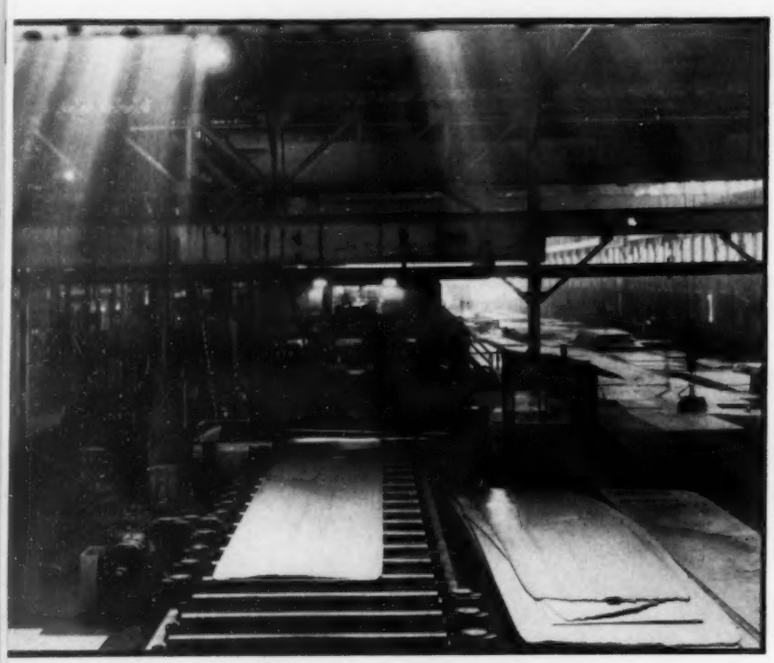


Plate leaving 120 in. mill can be directed to one of three 156 in. shears which can cut material up to 1¼ in. thick x 120 in. wide.

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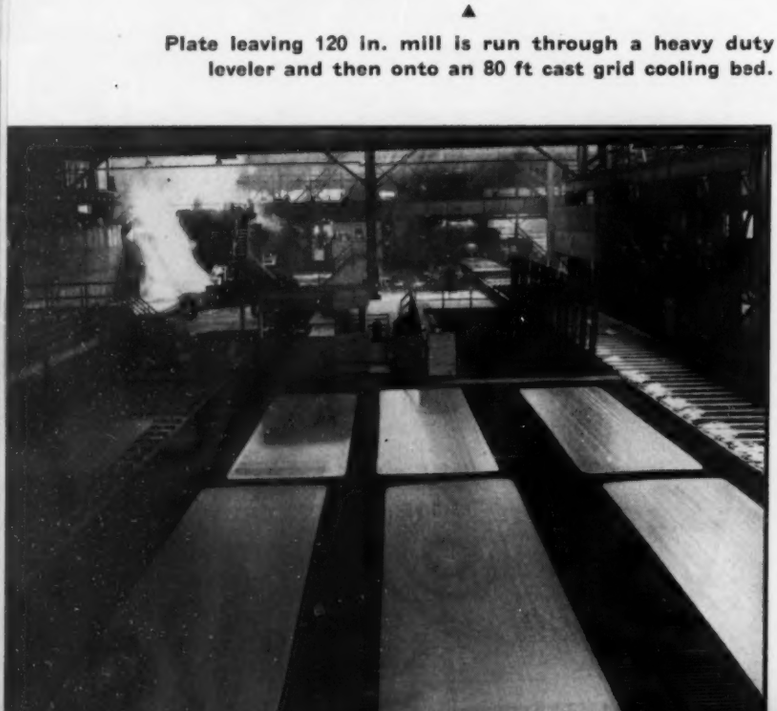
Plate leaving 120 in. mill is run through a heavy duty leveler and then onto an 80 ft cast grid cooling bed.



There are also two 1000 kw, 250 volt d-c motor generator sets which supply power for auxiliaries and are connected into the general plant d-c system.

A 6000 kw, 13,200/2300 volt transformer bank and a 2000 kw, 13,200/460 volt bank are located just outside the motor room. Metal clad switchgear is provided for power distribution.

The rotating equipment in the motor room is cooled by a ventilating system which maintains a slight pressure in the room. Air drawn from the outside is cleaned by passing through electrostatic precipitators, and is blown into the motor room by four 70,000 cfm fans. The air is drawn down through the machines and passes on to discharge ducts leading to the roof. Louvres in these ducts permit recirculation of the air back into the motor room in cool weather. No air cooling equipment is installed in this system.

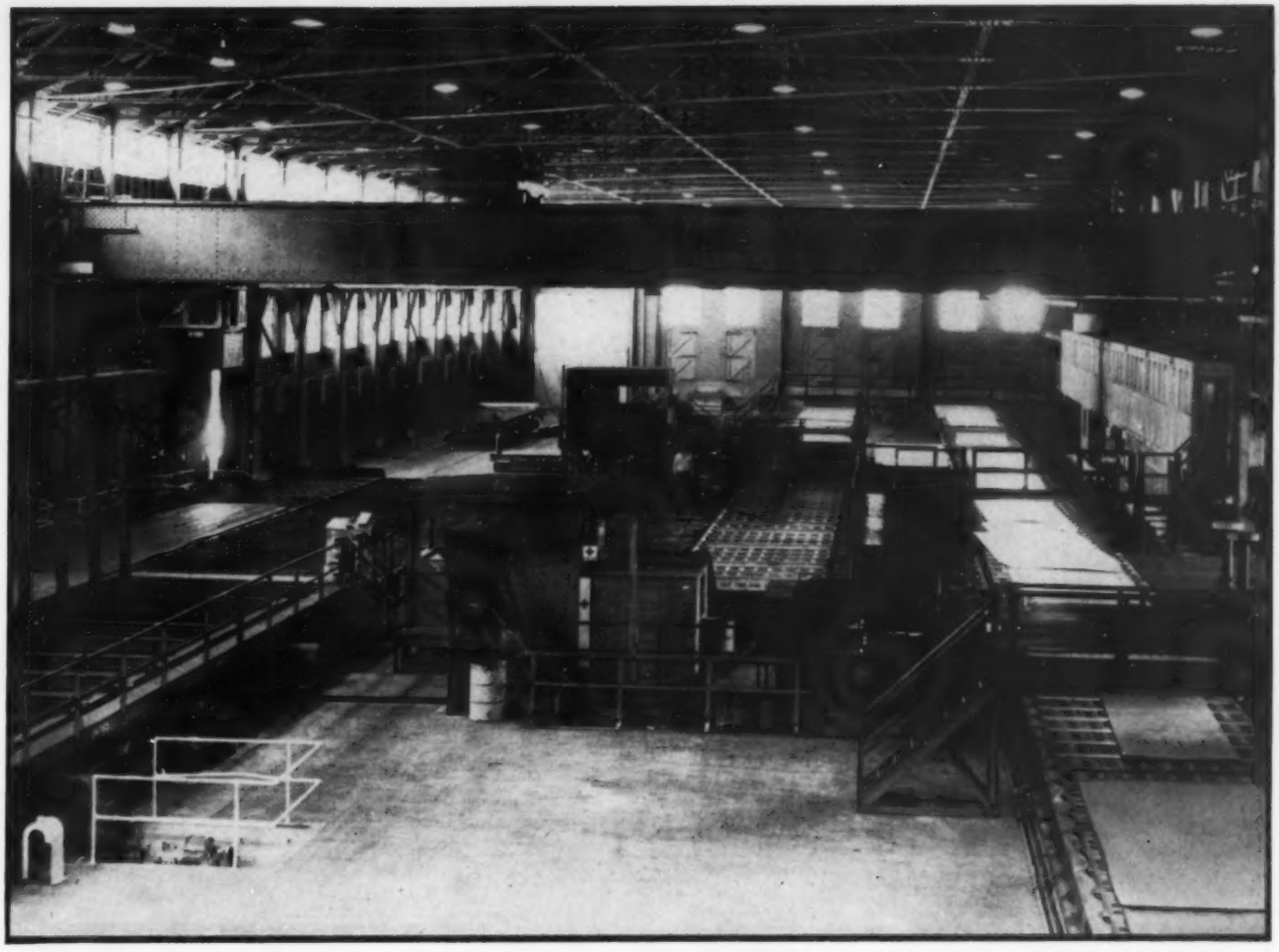
Some cleaned air is withdrawn from the ventilating system to cool the separate edger drive motor, and the 120 in. mill auxiliary motors and their motor generator set, which is a 700 kw multi-generator set located in a control house extending along the mill.

Approximately 130 ft beyond the 120 in. mill is a heavy duty leveler containing eleven rolls 10 in. in diameter and 124 in. long, and capable of hot flattening plate up to ½ in. thick. Leaving this leveler, plate may proceed down the runout table, which continues for about 300 ft, then over an 80 ft cast grid cooling bed to a parallel table which contains a nine-roll leveler with rolls 14 in. in diameter × 124 in. long, which can hot-flatten plates up to 1½ in. thick. The plate may then be kicked on to a piler or it may be taken over another 80 ft transfer to a third parallel table which contains a turn-over device for inspection purposes, a marking station, three 156 in. gate shears, one rotary side-trimming shear, one 146 in. gate shear and one 120 in. gate shear. One of the 156 in. shears is used as a crop shear, while a second unit, 210 ft away, equipped with shear gauge, is used for parting. Both of these units will cut material up to 1¼ in. thick × 120 in. wide. About halfway between the two is the rotary trimmer which will shear material up to ⅝ in. thick. Magnetic plate shifters position the plate properly for side trimming. Scrap choppers automatically cut up the side scrap, which is chuted into scrap buckets.

This last shearing table leads either to a castor bed which contains another end shear and two side shears, or to another parallel table which contains a scale table, where plates may be weighed and given a final inspection.

If the desired characteristics of the product necessitate heat treatment, plate leaving the leveler in the mill runout table is transferred over a 50 ft transfer to a table line which contains a three-zone continuous annealing furnace 123 ft long × 11 ft wide, fired with natural gas, and a thirteen-roll leveler with rolls 8 in. × 124 in. for plates ⅛-⅜ in. thick. The heat treated plates are then carried over a 50 ft transfer back to the runout table and then over to the cooling tables previously mentioned.

A depressed railroad track runs the full length of the shearing building, which is also used for storage and shipping. The building is equipped with three 20 ton cranes. Another inspection and shipping building nearby is reached by transfer car.



The plate runout tables, roller levelers, cooling bed and plate roller inspection turnovers are north of the 120 in. mill.

140 INCH AND 206 INCH MILLS

The other rolling units, although much older, are very important and have received much publicity because of the fact that they include a 206 in. mill, generally held to be the largest plate mill in the world. This mill is of vital importance in the overall scheme of operations of the plant, and generally operates in conjunction with a 140 in. mill.

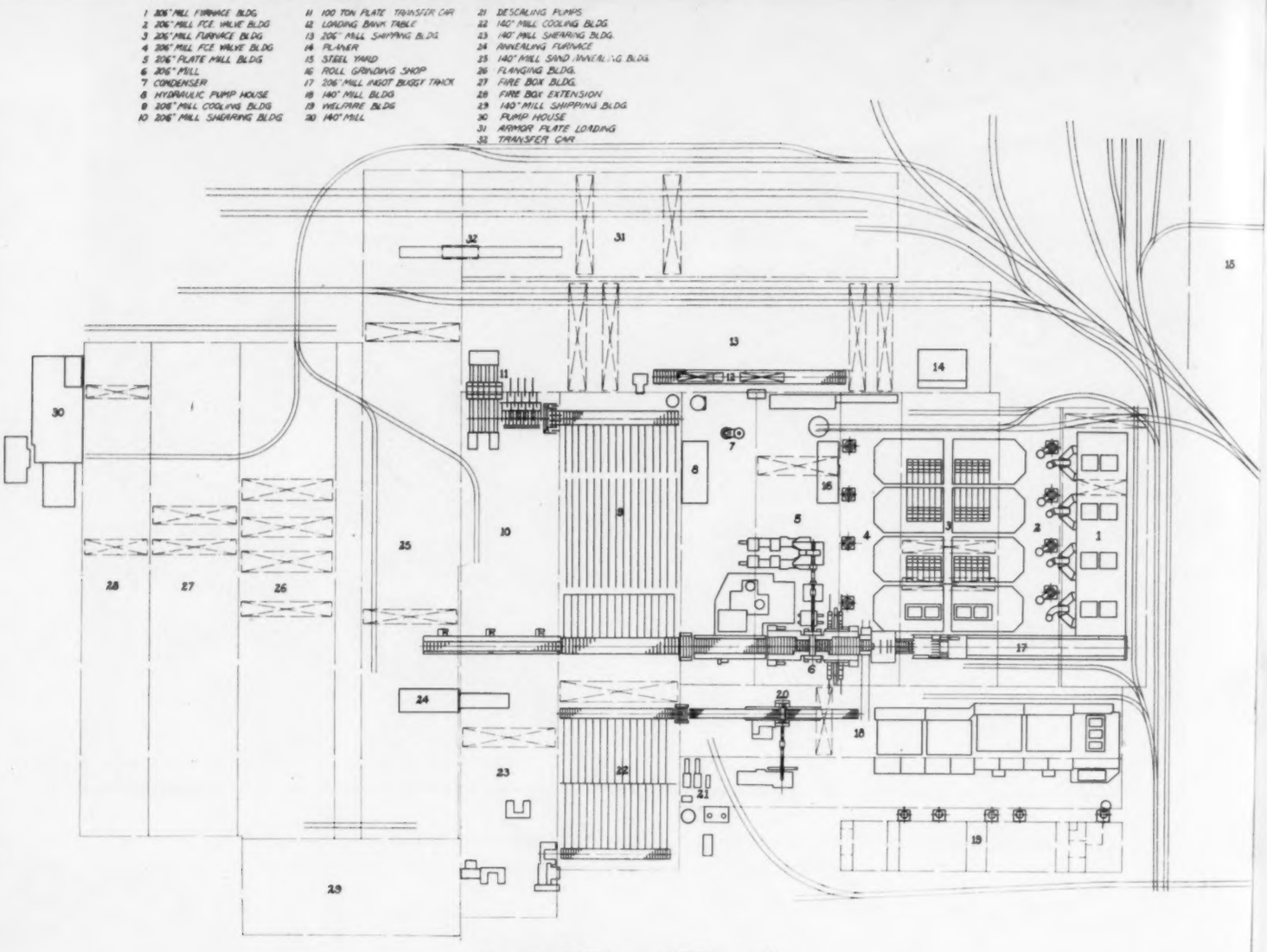
In the 140 in. mill building there are four rows of regenerative pits, each row of which has four holes 9 ft long × 5 ft wide × 6 ft deep, and one row of three recuperative pits each 11 ft 6 in. long × 6 ft 11 in. wide × 10 ft 6 in. deep. These pits are fired with natural gas, the regenerative units by four burners through the regenerator arch on each end of the pit, and the recuperative units through a single burner at the top of each. Full automatic control is provided for the recuperative pits.

Adjacent to the 206 in. mill buildings are additional heating facilities consisting of 6 rows of 3 holes each of regenerative pits and 6 rows of 2 holes each of recuperative pits. Regenerative pits are 9 ft long × 7 ft wide × 8-9½ ft deep, and are fired by natural gas through 3 burners in the checker chamber arch on each end, while the recuperative pits are 11 ft 9 in. long × 9 ft 3 in.-10 ft 6 in. wide × 11 f t are fired through two burners at the top of each. Eight of the recuperative pits are equipped with full automatic control. With cold ingots, heating time ranges 6-24 hr, depending on the ingot size and type of steel.

In each of the foregoing sections of heating equipment, ingots are handled by three overhead pit cranes. From the first group of pits, ingots are carried to the table of the 140 in. mill, while from the second group, an ingot car transports ingots to the table of the 206 in. mill. A transfer car carrying line table rollers operates between the tables of the two mills, so that ingots from either group of pits may be used in either mill, or the two mills may be used in combination as rougher and finisher.

There is also a gas-fired plate reheating furnace, 19 ft × 15 ft 3 in. × 2 ft 8½ in., installed beside the runout table of the 206 in. mill.

The 140 in. mill is a three-high single stand, driven at 68 rpm by a 46 in. × 60 in. 2250 hp Corliss noncondensing steam engine with flywheel. Top and bottom rolls are 38 in. in diameter, and the middle roll, which is fluted when the mill is being used as a rougher for the 206 in. mill, is 22 in. in diameter. Maximum opening between rolls is 24 in., and the rolls are hydraulically balanced. The middle roll is shifted by two hydraulic cylinders located in the pit under the mill. Mill screws,


1 206" MILL FURNACE BLDG.
2 206" MILL FCE. VALVE BLDG.
3 206" MILL FURNACE BLDG.
4 206" MILL FCE VALVE BLDG.
5 206" PLATE MILL BLDG.
6 206" MILL
7 CONDENSER
8 HYDRAULIC PUMP HOUSE
9 206" MILL COOLING BLDG.
10 206" MILL SHEARING BLDG.
11 100 TON PLATE TRANSFER CAR
12 LOADING BANK TABLE
13 206" MILL SHIPPING BLDG.
14 PLANER
15 STEEL YARD
16 ROLL GRINDING SHOP
17 206" MILL INGOT BUGGY TRACK
18 140" MILL BLDG.
19 WELFARE BLDG.
20 140" MILL
21 DESCALING PUMPS
22 140" MILL COOLING BLDG.
23 140" MILL SHEARING BLDG.
24 ANNEALING FURNACE
25 140" MILL SAND ANNEALING BLDG.
26 FLANGING BLDG.
27 FIRE BOX BLDG.
28 FIRE BOX EXTENSION
29 140" MILL SHIPPING BLDG.
30 PUMP HOUSE
31 ARMOR PLATE LOADING
32 TRANSFER CAR

Layout of 140 in. and 206 in. mills.

10 in. in diameter and of 1¼ in. pitch, are driven by one 60 hp motor.

Roll necks run in bronze bearings lubricated by grease. Mill spindles 18 in. in diameter connect the top and bottom rolls to herringbone pinions, which are of 6.283 in. pitch and 46¾ in. face. Pinion pitch diameters are 40 in. for top and bottom, and 24 in. for the middle pinion.

Ahead of the mill, tables 56 ft 10 in. long extend from the ingot transfer car to the mill. Counterbalanced tilting tables on each side of the mill are 27 ft 8 in. long and are operated by hydraulic cylinders. Table rollers are of disc type, and are driven through line shaft and bevel gears. In the tilting tables, dual drives are used, driving alternate rollers which are tapered in opposite directions so that ingots may be turned for cross rolling for greater width.

Following the mill, tables extend for 78 ft to a hot leveler containing 9 rolls 144 in. long × 14 in. diameter. From this leveler, the plate proceeds to a chain-type cooling bed 110 ft long × 90 ft wide, with hydraulically operated arms which raise the plate for inspection of the bottom surface.

From the cooling floor plates pass through two hydraulically operated gate shears, each with a 30 in. throat and a 144 in. knife, one for end cuts, the other for side trimming. In an adjacent building are two circle shears; one 190 in. in diameter, the other 140 in.

The 206 in. mill — "the world's largest plate mill" — is also a single stand unit, but of four-high design. Installed in 1918, this mill is one of the first four-high units in the United States. It is driven through a 2 to 1 reduction gear by a 46 in. × 70 in. × 60 in. twin tandem compound reversing steam engine which develops 10,000-12,500 hp at 90-150 rpm.

Back-up rolls, 50 in. in diameter and with bodies 206 in. long, operate in bronze bearings, and work rolls, 34 in. × 206 in., also run in bronze bearings, except for the bottom bearing of the top work roll, where a composition bearing is installed. All bearings are lubricated by forced feed.

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Chief Engineer—Lukens

WILLIAM C. A. BUSCH
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W. LOUIS BUNTING
Superintendent, Plate Mills—Lukens

J. G. ALTHOUSE
Metallurgical Engineer—Lukens, By-Products and Lukenweld

L. P. McALLISTER
Assistant to General Manager of Steel Plants—Lukens

WALTER H. BURR
Superintendent, Electric Department—Lukens

Maximum roll lift is 42 in. Two 150 hp motors operate the mill screws, which are 16 in. in diameter and of 2 in. pitch. Rolls are hydraulically balanced.

A lead spindle 12 ft 8¼ in. long × 27 in. body diameter connects the reduction gear to the pinions, which are of herringbone type, 8.799 in. pitch, 42 in. pitch diameter and 60 in. face. Connection between pinions and mill is made by a top spindle 20 ft 5 in. × 20½ in. and a bottom spindle 19 ft 9 in. × 20 in. Couplings are slipper type, with steel ring retainers.

Roller tables preceding the mill are 83 ft 8 in. in length and composed of rollers of both disc and barrel types, driven by line shafts and bevel gears. Above the approach table, there is a turnover mechanism consisting of three chain-suspended bars connected to an elliptical drum. The bars are lowered into the mill table and the ingot or breakdown run over the bars. Operation of the elliptical drum turns the ingot over without allowing it to drop upon the table. Front and back tables are provided with dual drives with alternate rollers tapered so that ingots may be turned in a horizontal plane for cross rolling.

On the exit side of the mill, tables extend for a distance of 95 ft 5 in. to a hot leveler containing 7 rolls 16 in. × 210 in. Following this is a chain type cooling bed 180 ft long × 90 ft wide, and in the runout table from this bed is a 206 in. hydraulically operated gate type shear with a capacity of 2 in. thick cold plate.

Instead of proceeding over the cooling bed, plate may proceed straight from the mill to an adjacent building for slow cooling or annealing. One car bottom furnace 41 ft 4 in. × 17 ft 2 in. is installed here, together with provisions for burying the plate in sand for slow cooling.

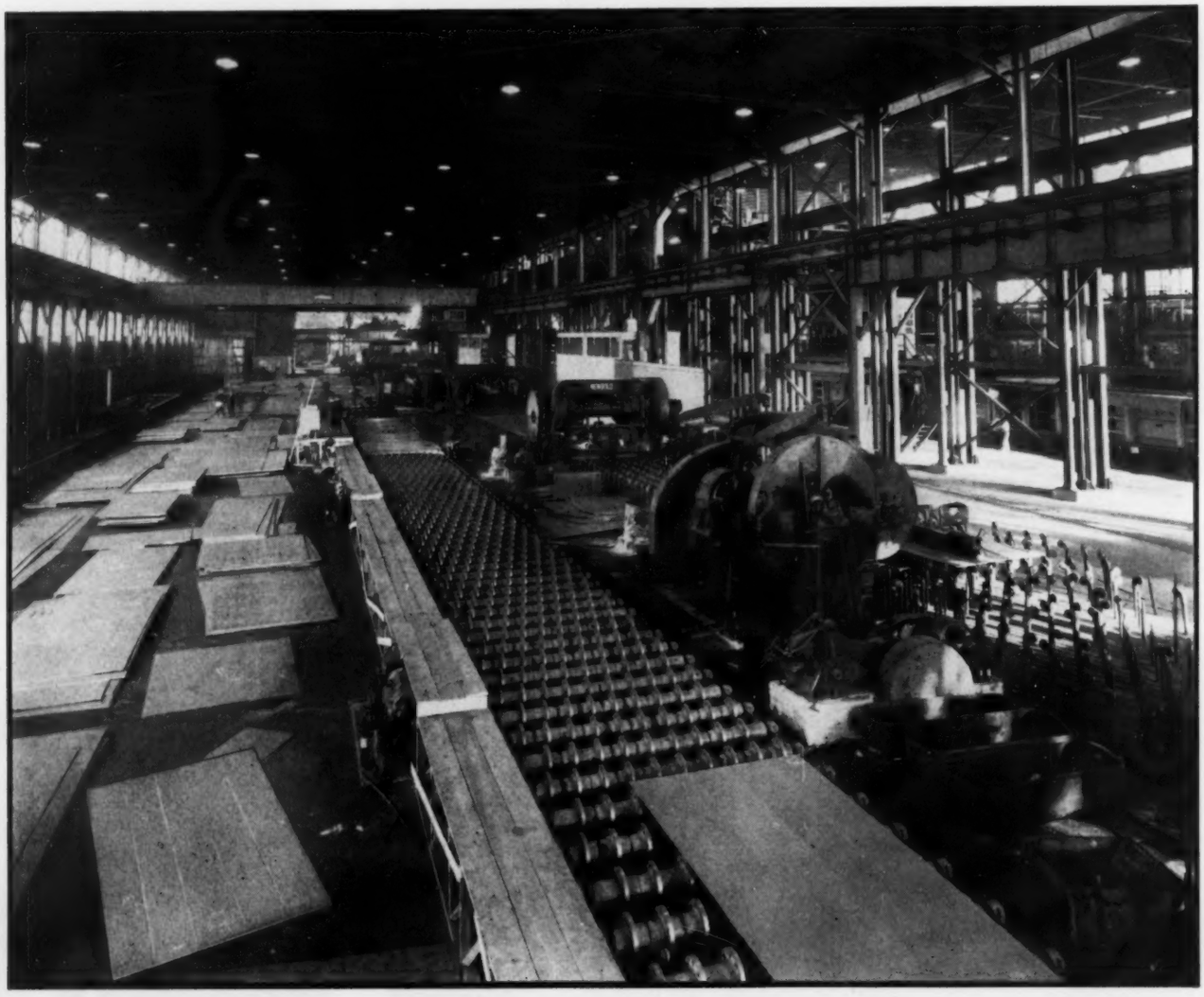
A 1300 psi hydraulic descaling system has recently been installed on both the 140 in. and the 206 in. mills, with sprays above and below the plate. Descaling is greatly facilitated by the fluted middle roll used in the 140 in. mill when it is operating as a roughing unit.

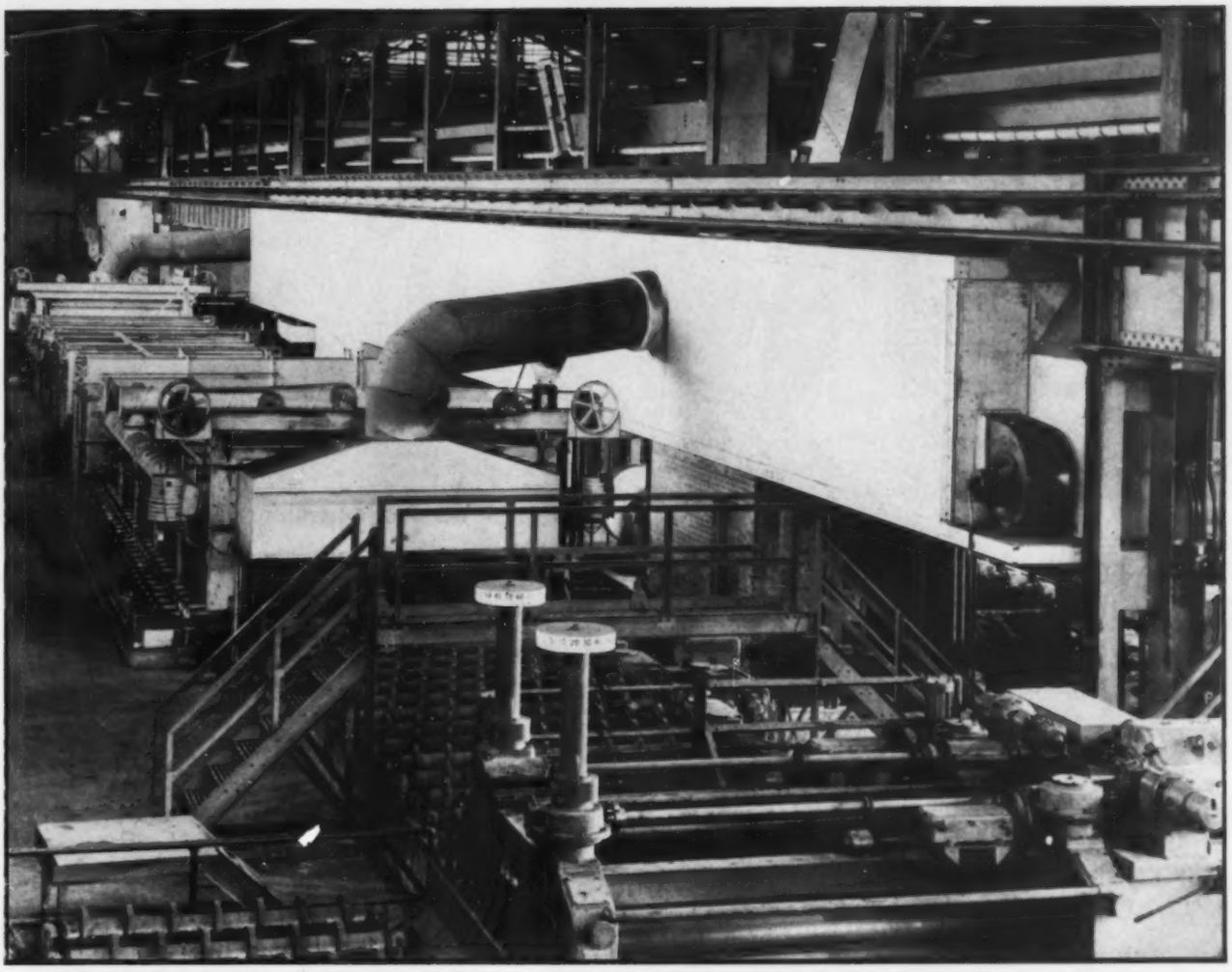
Plate in a wide range of sizes is produced, up to 195 in. in width or up to 25 in. in thickness.

Adjacent shipping buildings are reached by transfer cars.

Within the past year, two mills, a 48 in. universal mill and an 84 in. sheared plate mill, have been retired from service and are to be removed.

At the end of the cooling tables are auxiliary shears served by castor beds. A depressed track, which runs the full 580 ft length of the building, provides shipping facilities.

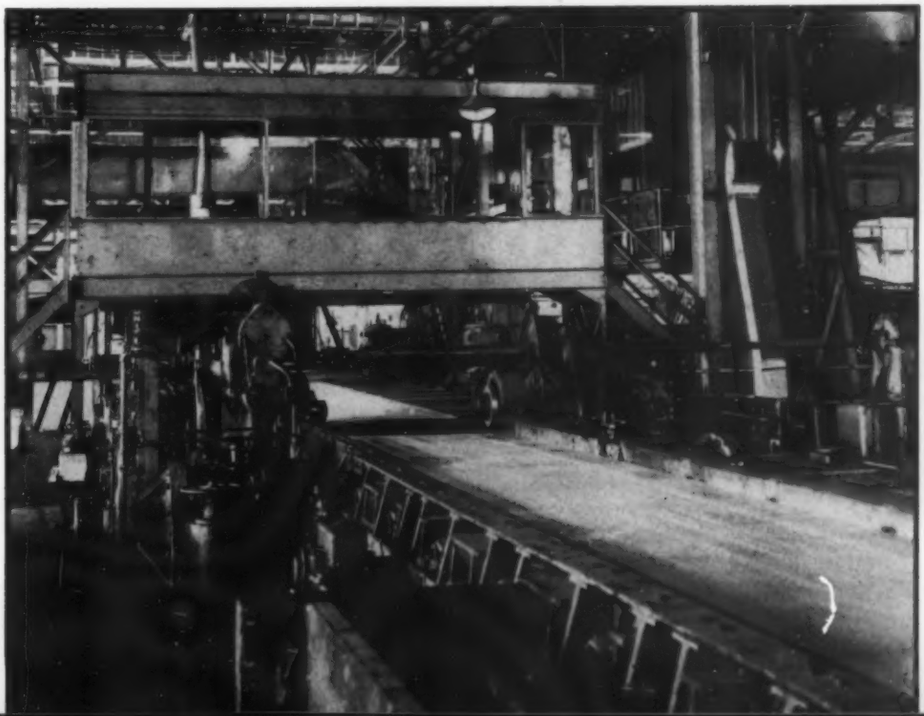




When heat treatment is required, plate is run through a three-zone continuous annealing furnace, and a 13roll leveler.

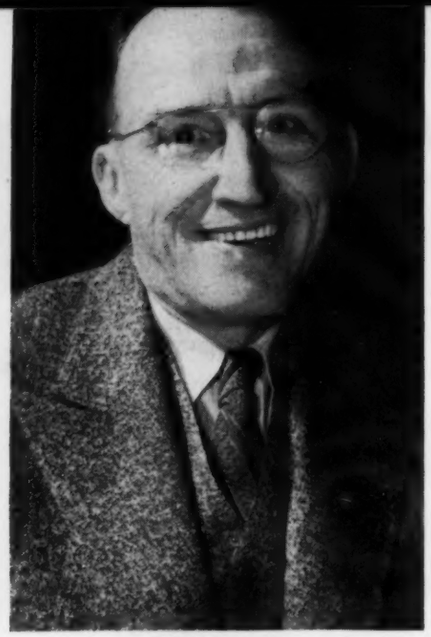
In supplying steel to the mills, two factors govern the selection of ingot size for a specific plate. Ingot thickness should be at least 1½ times the thickness of the plate to be rolled in order to assure adequate working and good scale removal. Also, ingot width should be about ⅓ the width of the final plate so as to keep side over-roll at a minimum.

In addition to ingots produced in the plant, a considerable tonnage of steel and nonferrous metals as aluminum, nickel, Inconel, Monel, stainless and copper.



This rotary side trimmer which serves the 120 in. mill, is located in one of the cooling tables paralleling the mill tables.

R. W. MOFFETT
General Manager, Fabrication—Lukens, By-Products and Lukenweld



R. M. DENNIS
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HENRY S. HALL
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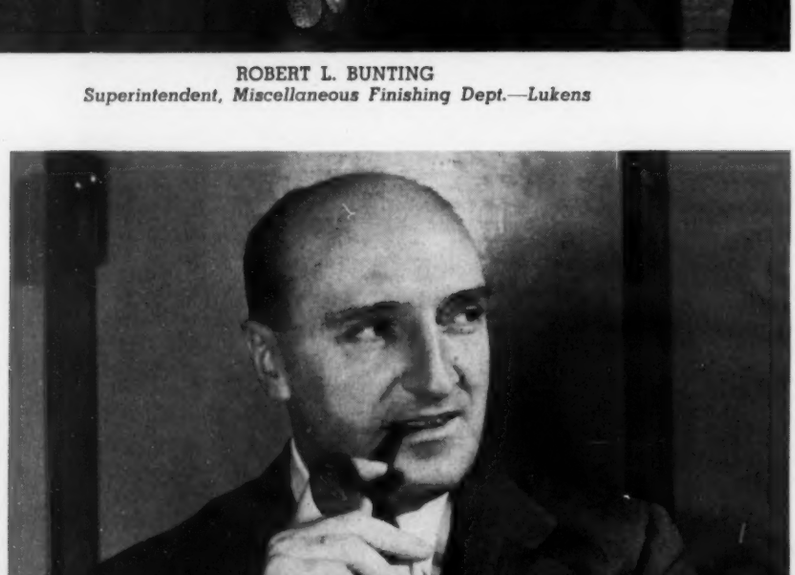
ROBERT L. BUNTING
Superintendent, Miscellaneous Finishing Dept.—Lukens

J. EDWIN PECKET
Superintendent, Flanging Department—Lukens



T. T. WATSON
Director of Research—Lukens, By-Products and Lukenweld

HARRY FOHL
Master Mechanic—Lukens

Air for ventilating the main motor room for the 120 in. mill is cleaned by passing through electrostatic precipitators.

from outside sources is rolled. Some of this is very wide material which can be rolled on no mill in the country except the Lukens 206 in. unit, while some is material for the production of clad steel by a process which is discussed later in this article.

FLANGING DEPARTMENT

Due south of the shearing and cooling buildings of the 140 in. and 206 in. mills and adjacent to them is the flanging shop. This is now one of the largest shops for spinning large heads, a product which has come far since the day in 1885 when Charles Lukens Huston, who is today still active as first vice president of Lukens, began the operation of the first spinning machine in what is now Lukens Steel Company. Prior to that time, heads had been formed by bumping, a process in which a heated plate was "bumped" into a hole in the ground, the hole being approximately the size and shape of the desired head. The first spinning machine could form heads up to 7 ft in diameter in gauges up to 1 in., but the first spinning machine at Lukens did not come up to expectations. After a few months, a new machine was designed using a curved guide for the outside roller to form the corner radius and straight flange. This design proved satisfactory and is standard today on most spinning machines.

With improvement in the design of spinning machines, and with the large plate width available, equipment was added to the flanging department so that the shop is now capable of forming the largest heads obtainable. Plate thicknesses up to 6½ in. have been spun, and heads with diameters over 18 ft or weighing as much as 36,000 lb have been made. The largest heads ever spun in one piece were used in a refinery fractionating tower. These heads were 18 ft 2½ in. outside diameter, 1 1/16 in. nominal gauge and ⅞ in. minimum gauge, with 170 in. radius of dish, 13 in. inside corner radius, 3⅛ in. straight flange, 48⅜ in. overall depth; and each weighed 15,700 lb. Flat circles 20 ft 9 in. in diameter were required for the flanging operation and these were obtained by welding two plates 251 in. long and 125 in. wide into a single square plate. The spinning of the head was done hot.

The world's heaviest spun heads which were also formed in this plant were required for the construction of petroleum reactors. The finished heads measured 15 ft 2 in. outside diameter and 2¾ in. nominal gauge, with a 3 in. straight flange, 47¼ in. overall depth; with each head weighing approximately 34,370 lb. These heads also were too large to be made from one plate, and two plates 116 in. wide 232 in. long and 2¾ in. thick were welded together to form the basis for the flat 230 in. diameter circle which was required. Five heating operations were required before spinning was finished on each head.

The number of heads which have been formed throughout the years have required thousands of different formers and dies, many of which are not available elsewhere. Hot spinning, in contrast to sectional or progressive flanging, minimizes development of residual strains which are inherent with sectional forming of heads.

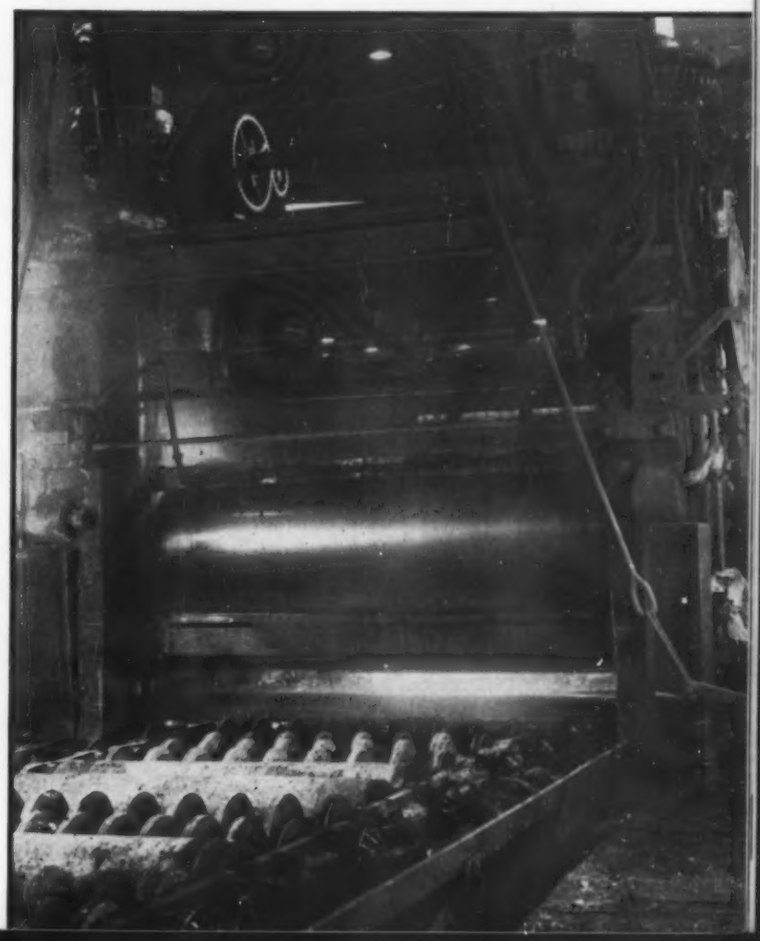
The spinning machines can form heads from 12 in. to over 218 in. in diameter or from 3/16 in. to over 6 in. in thickness.

Two heating furnaces, 19 ft 6 in. long × 18 ft wide × 5 ft 10½ in. high and fired with natural gas, serve the flanging units.

The spinning machines can form heads of all types, including flanged only, dished only, flanged and dished (both standard and ASME), elliptical, hemispherical, and conical. Heads can be formed with flanges squared, toed in, or toed out.

The flanging department also has several presses used to form large heads, and other presses which can also be

The three-high 140 in. mill, generally used as a breakdown mill for the 206 in. mill, is driven by a 2250 hp steam engine.



The 206 in. mill, also steam driven, is the largest plate mill in the world.

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Lukens flanging department spins some of the largest heads in the world.

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used for this work are located in the By-Products Steel Corporation. In the flanging department, there are two sectional flangers or hydraulic universal presses with capacities of 200 tons and one 500 ton universal flanging press. These presses are served by one 8 ft × 8 ft double end furnace with suspended roof 4 ft above the floor. The furnace burns natural gas, fired through five automatically controlled burners mounted on each side of the furnace.

Pressing heads is a large scale production process, the time and labor involved in forming one head being much less than for spinning. The expense involved for dies of the desired shape and size necessary is justified when the demand is sufficient.

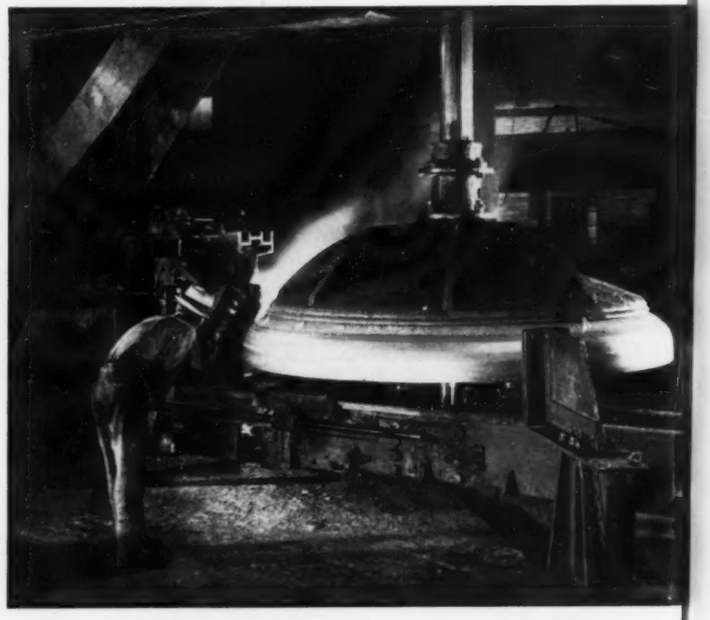
Pressing is preferable for forming certain alloys, such as stainless steel which will not remain plastic as long as carbon steels, and will not flow as readily under the rollers of the spinning machine.

Heads have been pressed up to 8 ft 6 in. diameter.

Other equipment in the flanging shop includes a 112 in. boring mill, a 16 ft vertical boring mill, two manhole facing machines, three portable radiagraphs with a motor driven turn-table and a torch for trimming the smaller heads, shears used to trim head flanges up to 120 in. in diameter and up to ½ in. gauge, and a decambering machine. There are also natural gas fired annealing furnaces.

CLAD STEEL DEPARTMENT

Important among the products of Lukens Steel Company are clad steels, developed in 1930 as a joint effort between Lukens Steel Company and The International Nickel Company. Lukens clad steels consist of a light layer of corrosion-resistant metal (nickel, inconel, monel or stainless) permanently bonded to a heavier backing plate of steel.



The technique of fabrication was arrived at in the construction of a tank car of nickel-clad steel, for the transportation of iron-free caustic soda for the rayon industry.

Developed to supplement the use of solid nickel and to make possible the construction of large corrosion-resistant equipment which otherwise would not have been economically possible, this bi-metal was quickly recognized as the answer to the economical construction of vacuum equipment. Nickel-clad steel was immediately adopted by evaporator manufacturers for the construction of evaporators for the production of high purity caustic soda.

In 1934, the needs of the wine industry were met by

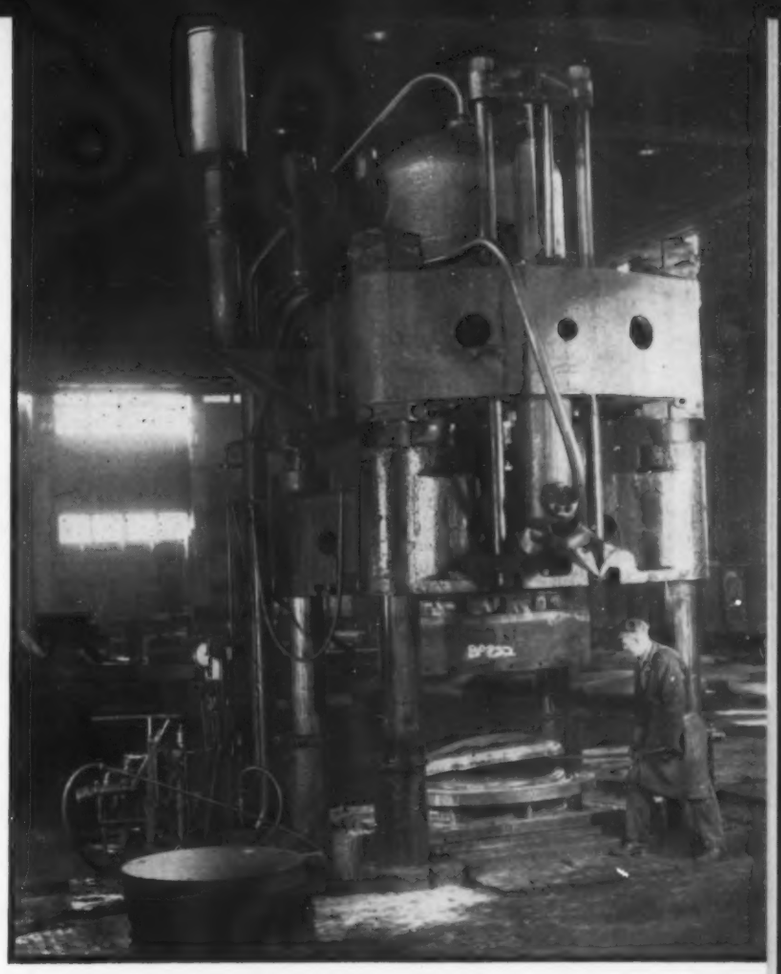
Lukens inconel-clad steel, produced especially for equipment used in the production of high grade domestic champagne. Among other applications for inconel-clad steel, subsequently developed were those in the food and pharmaceutical industries.

Later, monel-clad steel was developed primarily to meet certain needs of the salt industry and for increased resistance to sulphuric acid. It has found applications, also, in pharmaceutical manufacture and in the oil industry.

Most recent addition to the family of Lukens clad steels, stainless-clad steel, has just been introduced and it is expected to have a wide range of applications in many industries.

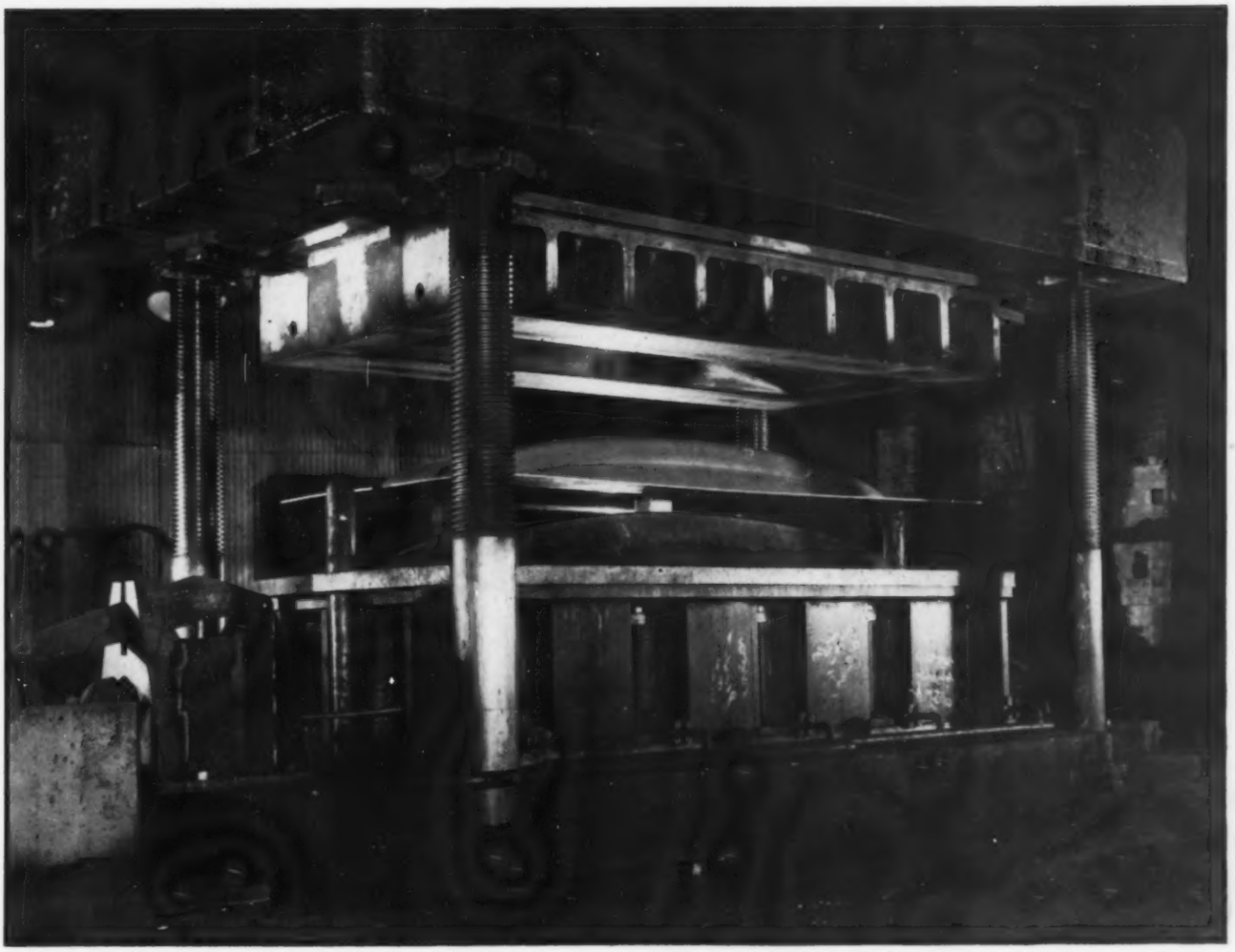
Usually the clad thickness is 10 per cent of the total plate thickness, although greater or lesser percentages are regularly produced.

Since the clad surface possesses the same corrosion-resistant properties as the solid nickel, inconel, monel or stainless, clad steels have been demonstrated to be entirely adequate, over a number of years, in combating many types of corrosive attack and in preventing harm-



By-Products Steel Corporation division also presses heads, and this 1500 ton press is in that division. →

This 1000 ton 4-poster press is here shown pressing a ↓ **buckle plate at By-Products Steel Corporation division.**



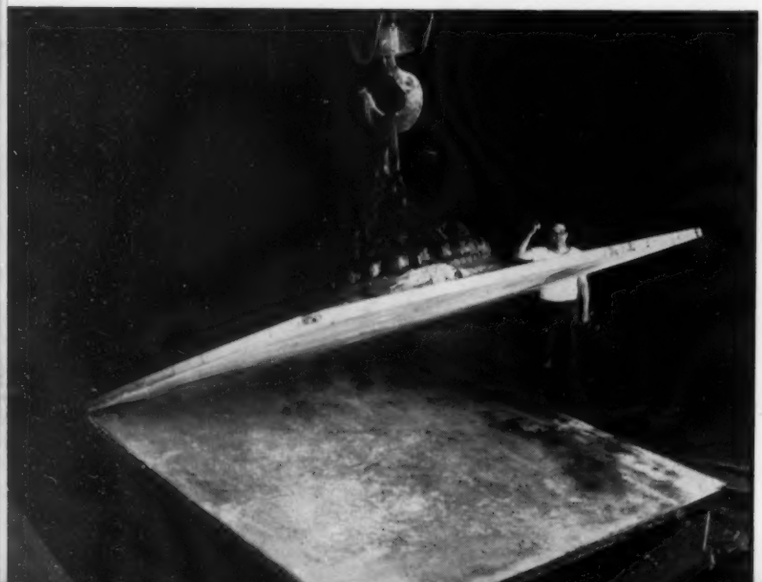
ful product contamination in a wide variety of equipment.

Lukens clad steels are produced by hot rolling. At the high temperatures employed in the production of clad steels, nickel (inconel, monel or stainless) and steel tend to alloy forming solid solutions at the plane of contact of the two metals. A solid-solution, high-strength alloy is formed at the interface. In preparing the plates for cladding, they are first grit blasted on the sides which are to be bonded and sand blasted on the faces which are to be kept apart. Next a sandwich is made up consisting of, first, a carbon steel plate, then a plate of the cladding material which is to be bonded to it, then another plate of cladding material, and finally another carbon steel plate. An infusible separating compound is put between the two plates of the cladding material. The carbon steel plates are made slightly longer and wider than the cladding plates, so that after the sandwich is formed there is a groove running around the four sides of the assembly. The groove is filled with space bars, all welded so as to hold the assembly together in one integral piece during the rolling process. The composite slab is then heated in the furnace to about 2300 F, and rolled in the plate mill. The rolling pressures on the composite assembly reduce its thickness while bonding the clad metal and the steel together. After rolling, the four edges of the plate are sheared inside the weld and the plates are separated on the layer where the anti-stick compound was originally placed. The resulting product consists of a carbon plate with a thin layer of the clad metal permanently bonded to one surface.

In the sandwich made up for clad plate, an infusible separating compound is applied to the faces of the cladding material.

▲

After rolling the clad sandwich, the two parts are separated into two clad-steel plates.



The widest clad plates which have ever been produced are rolled on the 206 in. plate mill previously described. These plates measure 162 in. in width and from ⅜ in. to 1½ in. in thickness. Clad plates can be formed and fabricated almost as desired, in much the same manner as ordinary plate.

In addition to clad materials, other products are made through the use of the same bonding principle. Steam platens are made by this method. Such platens are made from three-decker sandwiches in which bottom and top pieces are normal plates, while the middle plate consists of a labyrinth which has been made by cutting a long continuous slot into a plate, usually with a torch. An outside bead is welded around the assembly to hold the unit together during the heating and rolling operation. The sandwich is then heated in the furnace and rolled to the required thickness. This method of manufacture affords a wide range of designs and shapes, which can be used for cooling purposes as well as heating purposes.

HEAT TREATMENT DEPARTMENT

Lukens is in a particularly favorable position to offer a complete heat treatment service, as the result of its diversified and extensive facilities. There are fifteen full-size heat treating furnaces available at Lukens, By-Products and Lukenweld, in addition to several electric box-type furnaces for experimental purposes in the laboratories.

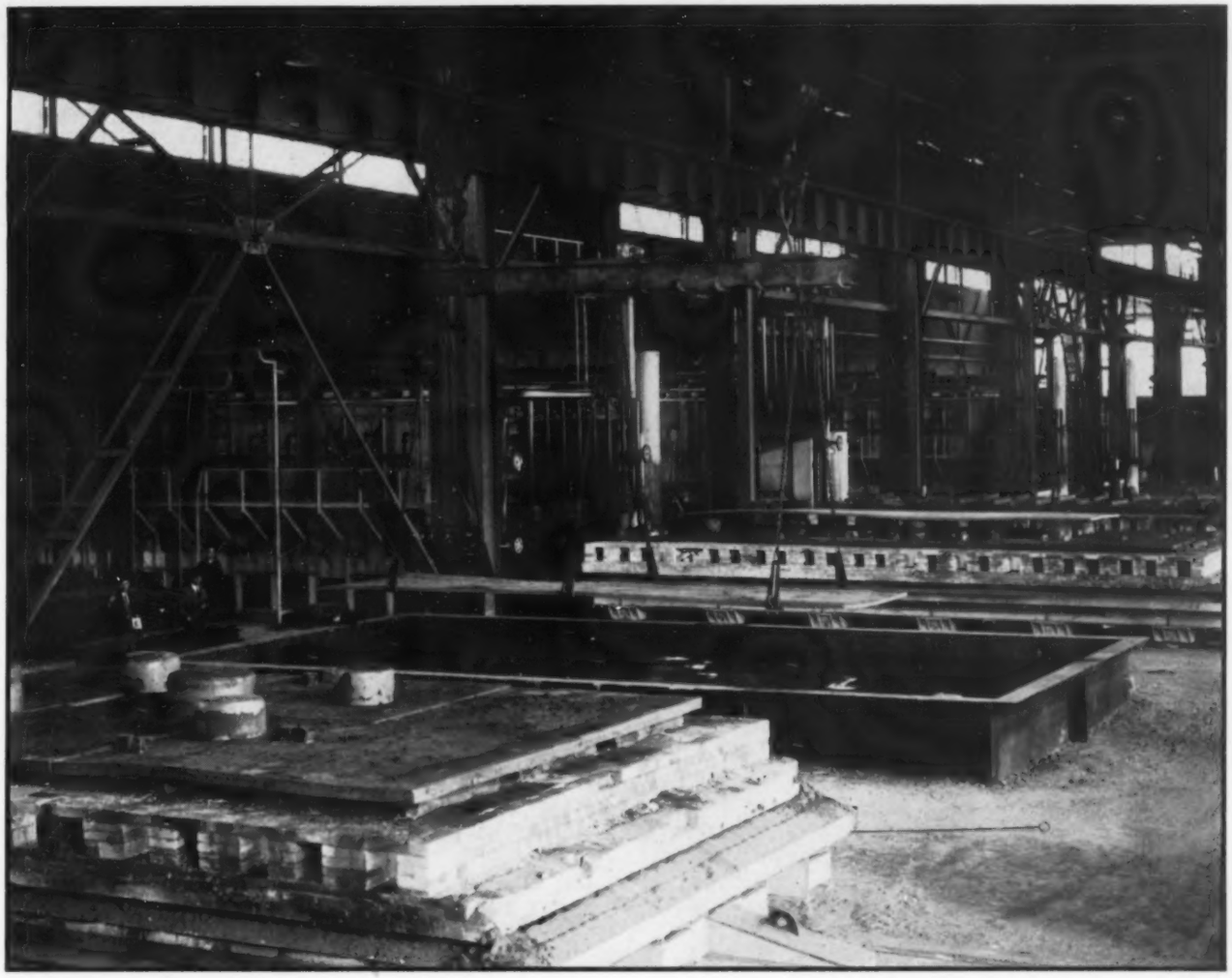
Lukens furnaces for annealing, normalizing, spheroidizing, hardening and tempering are available up to 41 feet deep, with door openings 6 ft high by 17 ft 2 in. wide. Maximum weight accommodated is 575 tons. For stress relieving only, furnaces are offered up to 20 ft deep, with door openings 12 ft high by 16 ft wide, accommodating weights up to 50 tons.

The majority of these furnaces are of the modern car-bottom type, gas-fired, with temperature automatically controlled according to the requirements of each charge.

Among Lukens hardening equipment is a large quenching tank, equipped with modern spray system, 40 ft long, 20 ft wide, 7 ft deep, for meeting hardness tolerances precisely.

In addition to heat treating carbon and alloy steel (plates, heads, shapes, and weldments), stainless steel is heat treated in these furnaces. 18-8 types of stainless are frequently heat treated and quenched to improve corrosion-resistant properties.

Auxiliary facilities are offered including grit and sand blasting; straightening and flattening; pickling, painting, oil treating; X-raying, magnaflux testing and photomicrography.



Complete heat treating facilities provide means for scientific heat treatment including the precise meeting of hardness tolerances. ↑

▲

Locomotive side frames are shown being flame-cut three-at-a-time at By-Products Steel Corporation division. The master template is shown at the right. →

BY-PRODUCTS STEEL CORPORATION DIVISION

A subsidiary, By-Products Steel Corporation, was established in 1927 to reduce scrap loss in industry through supplying steel plate shapes and prefabricated parts, produced by means of flame-cutting, bending, shearing, pressing, blanking and other processes. The unnecessary freight cost, the economic waste when plates are shipped to users for these operations, are averted through By-Products facilities, where plates are preformed before shipment. Thus, much of the scrap incident to prefabrication operations is kept in the plant where it is re-charged in the open hearth furnaces.

By-Products Steel Corporation consists of executive, engineering and sales offices, and five shops, three of which are devoted mainly to shearing, bending and pressing, while the other two major in flame cutting.

Among the products made are railroad specialties such as support plates for brake beams, hopper car chutes, truck frames for industrial railway cars, pressed end door plates for gondola cars, shim plates and locomotive side frames. One of the most interesting operations is the flame cutting of locomotive side frames. These pieces are cut from steel plate 5½ in. thick and are cut three at a time. Flame cutting is done on pieces up to 30 in. in thickness. Other products which are made include such varied items as base plates for buildings, component parts for heavy machinery, gears and sprockets. The latter in some cases are flame-cut so accurately that no machining is required.

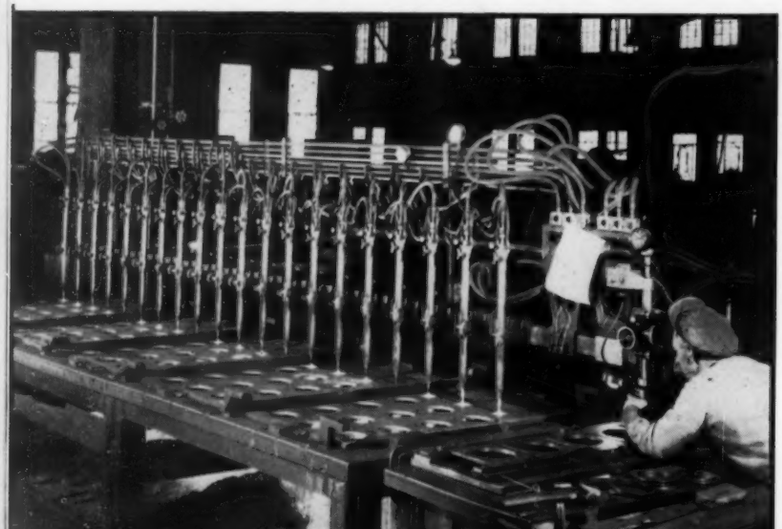
Many types of complicated shapes are cut out by shearing plates up to 1¼ in. without dies.

The largest presses in the plant are located in the shops of By-Products Steel Corporation and range up to 1500 ton capacity. With this equipment, the production of pressed steel parts of many types is accomplished, which at first glance, it would seem possible to make only by casting or forging. Special pressed shapes are made of plate ⅜ in. to 6 in. or more in thickness. Some of these products are combustion chamber heads for boilers and large brake rims for draw works for oil well drilling rigs. In the latter, the flat circle required for forming the brake drum is 78¾ in. in diameter and 1½ in. thick, and the completed brake rim, measuring 64½ in. outside diameter, is 10⅜ in. deep and weighs about 2143 lb. Other items formed are motor frame sections, bearing shells, mooring bitts, pipe elbow segments, manhole covers, collar flanges, and drier shells.

In general, the grade of steel used for pressing operations is plain carbon, although some low alloy steels are used. Heat treatment of the finished product is usually unnecessary, but if stress relieving is required, it is performed before the part is shipped.

A good deal of bending work is done and the company has several large press brakes, up to 18 ft long; as well as several bending rolls. This equipment is used to form heavy steel rings and shells, and even box girders are formed through the bending of a single plate, thus necessitating the welding of fewer seams on such a girder. Buckle plate panels, tanker bulkheads, and mooring bitts are in demand for ship construction.

All flame cutting in the plant is done with natural gas.



Multiple flame cutting at By-Products Steel Corporation division gives mass production economies.

▲

Large, heavy steel plate rings can be rolled on the 48 in. bending rolls at By-Products Steel Corporation division.

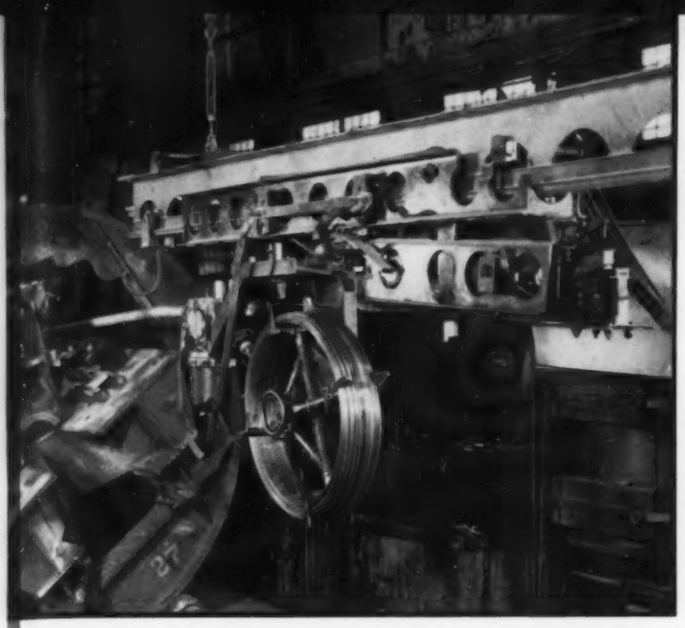
LUKENWELD, INC. DIVISION

Pioneering in the design and engineering utilization of welded steel construction, another subsidiary, Lukenweld, Inc., was established in 1930 — the first commercial weldery in America.

Today Lukenweld offers complete engineering and welding facilities for design and fabrication; specializing in custom-made weldments largely engineered in its own plants. However, many production-line items are also accommodated by the 234,410 sq ft of floor space.

A variety of welding methods are employed in the Lukenweld shops to meet the requirements of steel and alloy fabrication. While manual arc-welding, both a-c and d-c, plays the preponderant role, automatic machine welding is extensively used. Other methods include atomic hydrogen welding, flash welding and gas welding.

Lukenweld products include frames for diesel, gas and steam engines, drier rolls for paper, chemical and allied industries, impression cylinders, elevator cage frames, power units, bedplates, girder beams for bending



Diesel engine frame in Lukenweld horizontal turner is being welded with automatic welding machine at Lukenweld division.

rolls, melting pots, calender frames, gear cases, gear blanks, press frames, blower components, earth-moving equipment components, hoist drums, engine beds, pump bases, and even dredge ladders.

Among the fabricating facilities, are special welding positioners and straightening machines designed and built by Lukenweld, also presses, a special shapes mill, complete machine shop, flame cutting machinery, spectrograph, X-ray, stress relieving furnaces, grit-blasters and other specialized equipment to meet modern production needs. The machine shop equipment includes planers, lathes, saws, shapers, drill presses, boring mills (both horizontal and vertical) grinders and cutters, as well as facilities for leveling, straightening, cleaning and finishing. Four large heat treating furnaces for stress relieving are available, in addition to Lukens extensive facilities for heat treatment of plates, heads and shapes.

PLANT SERVICES

Power — Electric power is supplied to the entire plant by three 13,200 volt, 3 phase, 60 cycle delta-connected power lines from the Newlinville substation of the Philadelphia Electric Company. Each line is capable of delivering approximately 10,000 kva and is protected by directional overcurrent relays at the steel plant end and by inverse time overcurrent relays at the substation.

All three of these feeders are connected to a common metering bus through line disconnects, 250,000 kva, 600 amp, outdoor oil blast circuit breakers, and bus disconnects. Power is then distributed by five feeders connected to the common bus through bus disconnects and outdoor oil circuit breakers duplicating those used on the incoming lines. All of this equipment is protected by bus differential relay protection.

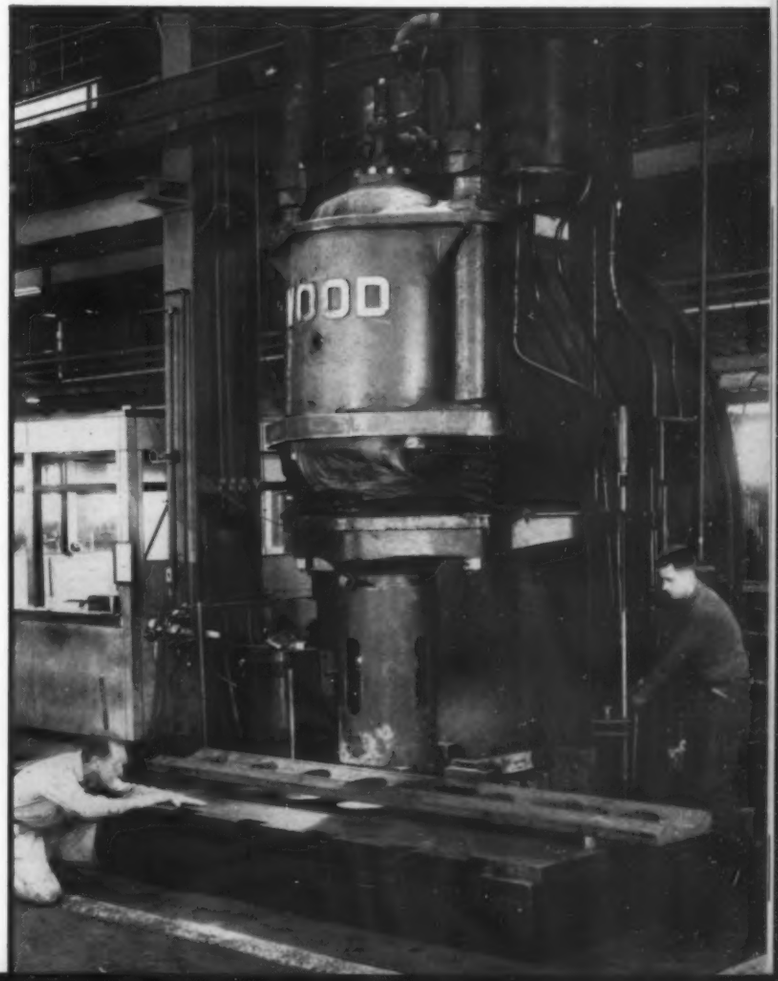
One 13,200 volt feeder supplies the new 120 in. mill main drive and all mill auxiliaries. This feeder is protected between the main substation and the 120 in. mill by pilot wire differential relays with inverse time overload relay back-up protection. At the 120 in. mill, power is distributed to the 6000 hp motor generator set, a 6000 kva 13,200/2300 volt transformer bank, and a 2000 kva 13,200/440 volt transformer bank by metal-clad switchgear with 250,000 kva 1200 ampere drawout oil circuit breakers. This switchgear is protected by bus differential relays, and each feeder and the apparatus connected to it is supplied with differential relay protection and inverse time overcurrent relay backup protection.

Two feeders from the main substation supply 6000 kva 13,200 volt delta-connected transformer banks, each of these feeders and their transformer banks being equipped with both differential and inverse time overload relay protection. The 2300 volt power from both transformer banks is distributed throughout the steel plant area by eight feeders, each protected by inverse time overload relays. This power is used to drive the roughing stand of the 120 in. mill, air compressors, pumps, 250 volt d-c auxiliary motor generator sets, and numerous transformer banks for general power distribution.

The fourth feeder from the main substation supplies By-Products Steel Corporation by feeding a 2000 kva 13,200/2300 volt delta-connected transformer bank. This 2300 volt power then supplies hydraulic pumps, air compressors, 250 volt d-c auxiliary motor generator sets, and transformer banks for general power distribution.

The fifth feeder supplies Lukenweld, Inc. and also the general water system pumps. This feeder is connected to a 600 kva 13,200/2300 volt delta-connected transformer bank feeding special welders and the 250 volt d-c auxiliary power motor generator sets at plant No. 1 of Lukenweld. At plant No. 2, the same feeder supplies a 2000 kva 13,200/2300 volt delta-connected

Flattening a diesel engine component on a press at Lukenweld division.



Test set-up to determine actual stresses under load on expansion joint subject to internal hydrostatic pressure at Lukenweld division.

transformer bank feeding a small special shapes rolling mill, the office building, and air compressors. The general water system is supplied by the same 13,200 volt feeder which is connected to a 2000 kva 13,200/2300 volt 3 phase transformer. This 2300 volt power is then used to run approximately 1600 hp of connected pump load.

All main and subsidiary plant general power distribution consists of 440 volt 3 phase supply for power, 220 volt 3 phase supply for lighting and 110 volt single phase supply for office machinery, unit heaters, water coolers, instruments, etc. At Lukens Steel Company there is approximately 6600 kva of connected transformer capacity for general power distribution and 6800 kw of 250 volt d-c auxiliary power motor generators. At the By-Products plant, there is 1730 kva of connected transformer capacity for general power distribution and 1850 kw of 250 volt d-c auxiliary power motor generators. At Lukenweld, there is approximately 7500 kva of connected transformer capacity for general power distribution (which includes welding services), and 550 kw of 250 volt d-c auxiliary power motor generator sets.

Water — Water for the plant originates from Brandywine Creek which runs through the plant property. In dry seasons, the flow in the creek may drop as low as 5000 gpm, while plant requirements reach 30,000 gpm. About one-third of this demand, used for condensing steam exhausted from the engine driving the 206 in. mill, is pumped from pools formed by dams in the creek, and the water is returned through cooling sprays.

The remainder of the water requirement is pumped from the creek approximately 1½ miles below the plant by two 11,000 gpm centrifugal pumps, which deliver it to a reservoir 1050 ft long, 180 ft wide and 15 ft deep. From the reservoir, two 10,000 gpm, 105 psi centrifugal pumps deliver the water through a 30 in. main into the plant distribution system, where a pressure of about 45 psi is maintained.

Steam — There are two producing centers that supply steam for the entire plant. The main steam generating plant contains four coal-fired water tube boilers rated at 15,000 lb per hour of steam at 150 psi, 550 F total temperature. Steam from this source, along with steam generated from waste heat, is used on the 140 in. and 206 in. mill steam engines, and for processing, heating and oil atomization. An internal water treatment process is used.

There are 16 waste heat water tube boilers rated at 13,800 and 19,500 lb per hr of steam at 150 psi, 500 F total temperature. These are fired principally with flue gases but facilities for both oil and natural gas firing are also provided on five boilers. Each boiler is equipped with an induced draft fan with a capacity of 40,500 cfm, 8.5 in. static pressure at 475 F. These fans have variable inlet vanes for draft control.

Fuel — Fuel used in the plant include coal, natural gas and bunker "C" fuel oil.

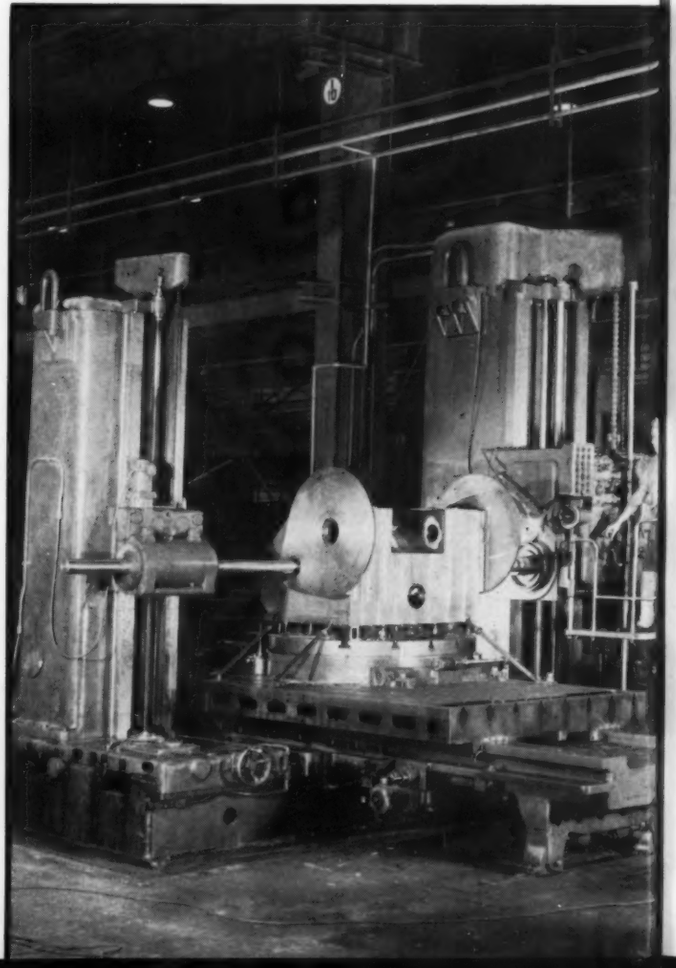
Coal storage is located about 1300 feet north of the coal-fired boilers below a broad gauge trestle. This stock is kept fairly constant, through regulation of demand and supply, to avoid excess handling. Coal is loaded for use by overhead crane.

Fuel oil is pumped to the open hearth, 120 in. mill and waste heat boilers at 175 psi and 190 F temperature through a circulating system. Two pumps in the return lines maintain constant circulation. A thermostatically controlled heater in the 120 in. mill raises oil temperature to 210 F before it is introduced to the furnaces and pits.

Natural gas is distributed throughout the plant at a pressure of 42 psi. This pressure is reduced to the required pressure at the point of usage.

Fuel oil and natural gas are metered at points of usage.

Horizontal boring mill at Lukenweld division.



At Lukens Steel

...WOOD hydraulic equipment again proves it's worth

▶ For many years Lukens steel men have known, used and liked Wood hydraulic control equipment. So, when plans were drawn up for hydraulic descaling systems for the four plate mills in the big Lukens plant at Coatesville, Pa., R. D. Wood engineers were called upon to assist in the design and construction of the systems. Included in these systems are 32 R. D. Wood inverse flow, automatic spray-control valves; low pressure filling valves; pilot valves; needle valves and Wood accumulator safety shut-off valves, as well as the controls for the operation of the air-bottle accumulator. The working pressure of the systems is 1,200 lbs. which requires four 1,000 gpm pumps of 900 hp rating.

There is, however, much more to a hydraulic descaling system than a collection of component parts. To be efficient, economical and satisfactory in service, a system must be carefully planned by experienced engineers. That is why Wood was consulted on this work at Lukens and why they can help you solve your hydraulic problems.

Ask your consulting engineer about R. D. Wood, or call in a Wood engineer from a nearby sales office. R. D. WOOD COMPANY, Public Ledger Building, Independence Square, Philadelphia 5, Pa.

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FORT WAYNE, IND., Herman L. Krouse, 4217 Buell Drive
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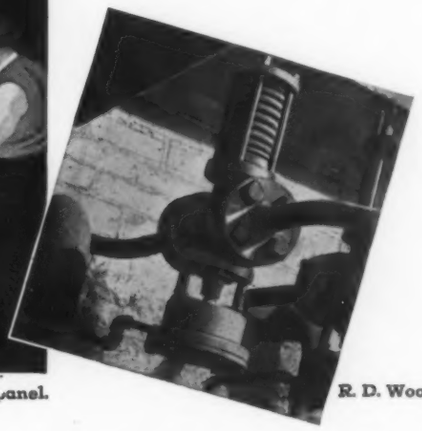
PITTSBURGH, PA., J. Thomas Holveck, P.O. Box 8564, Wabash Station
TORONTO 2, ONT., Storey Pump & Equipment Co., Harbour Commission Building

Shown above, R. D. Wood accumulator safety shut-off valve and Wood control panel.



R. D. Wood spray valve.

HYDRAULIC PRESSES AND VALVES
FOR EVERY PURPOSE • ACCUMULATORS
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R. D. WOOD COMPANY

EST. 1803

*'Surface' Continuous Annealing and Normalizing Furnace for treating a wide range of plate, varying from 3/16 inch to 1½ inches in thickness and up to 110 inches width. This furnace has a total inside length of 123 feet, of which 75 feet is devoted to the heating zone and 48 feet to the cooling zone.

It is equipped with 'Surface' High Pressure Velocity Burners for above and below hearth firing in the heating zone, and underfiring burners in the cooling zone to offset radiation losses when it is operated for blue annealing or slow cooling. In order to provide an extremely wide range of cooling, the cooling zone is equipped with a special flue gas cooler, dehydrator and recirculator.

'Surface'

SURFACE COMBUSTION CORPORATION

RACES *for* BIG MATERIALS

AT LUKENS PLANTS...

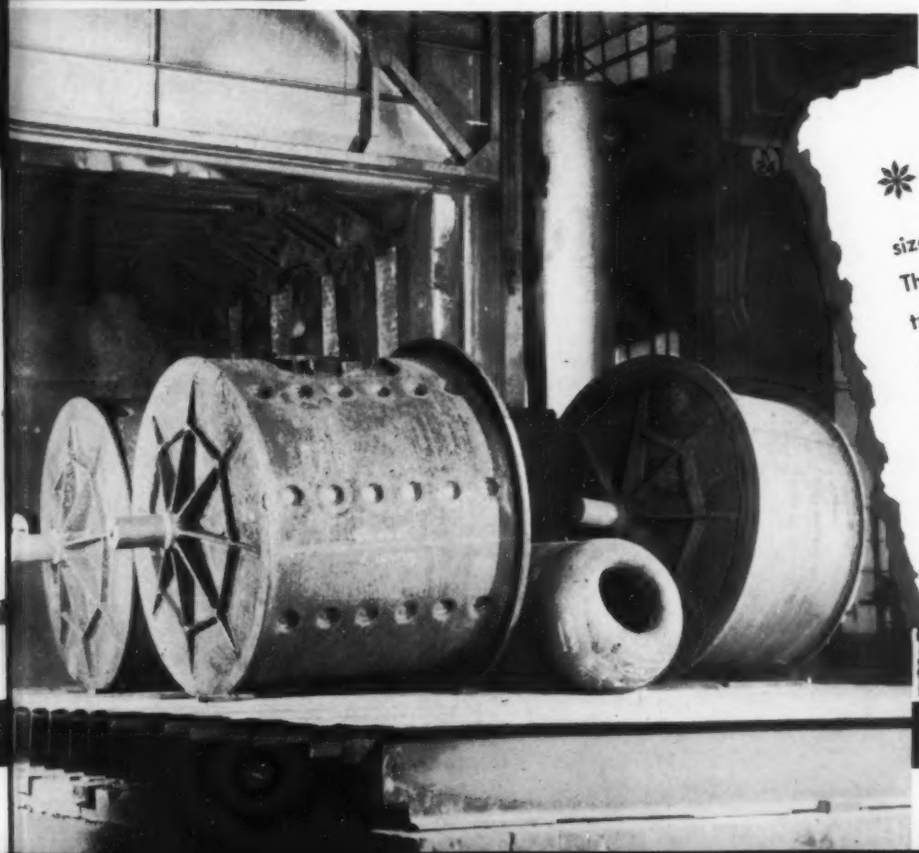
'Surface' PROVIDED FURNACES FOR SIZE, AND EXACTING CONTROL AND FLEXIBILITY OF USE, TOO!

FURNACE EQUIPMENT in steel producing and fabricating may necessarily be of special nature to meet the requirements of the materials to be processed. At Lukens Steel Company, and one of its subsidiaries, Lukenweld, Inc., this problem has been taken care of with the use of 'Surface' Industrial Furnace Equipment, especially engineered for the job.

Two of these units are herewith illustrated . . . a continuous annealer and normalizer—one of the largest of its type known for the processing of plate, and a giant size car-bottom type stress relieving furnace which utilizes convection heating in its operation.

These furnaces are representative of the almost unlimited kinds of furnaces and heating equipment 'Surface' offers to the steel mill. This equipment includes One-Way Fired Soaking Pits—Slab Heating Furnaces—Billet Reheating Furnaces—Continuous Heat Treating Furnaces for Plate—Pit Type Convection Furnaces for Annealing Rod, Wire, or Strip in coils—Continuous Strip Annealers and Normalizers—High Alloy Rod and Bar, Atmosphere Annealing Furnaces of Car-Bottom, Lift-Cover Type—Bright Annealing and Normalizing Furnaces for Tubing—Stress Relief Furnaces—Wire Patenting Furnaces—Annealing Covers, and the foremost equipment in Prepared Gas Atmosphere Generators for practically every heat treating operation.

It will pay you to submit your present heating and heat treating problems to 'Surface' for up-to-the-minute engineering advice and equipment.



✱ 'Surface' Car-Bottom Type Stress Relieving Furnace is used for various sized fabricated structural steel parts. This furnace is of a recirculating hot air type and is equipped with a 'Surface' Air Heater and a recirculating fan, mounted on the furnace top. It has a maximum load capacity of 80,000 pounds. Internal length from door to rear wall 21'-6"; Internal width from wall to wall 18'-6"; Width of car deck 16'-0", and height from top of rails to underside of return air ducts is 11'-0".

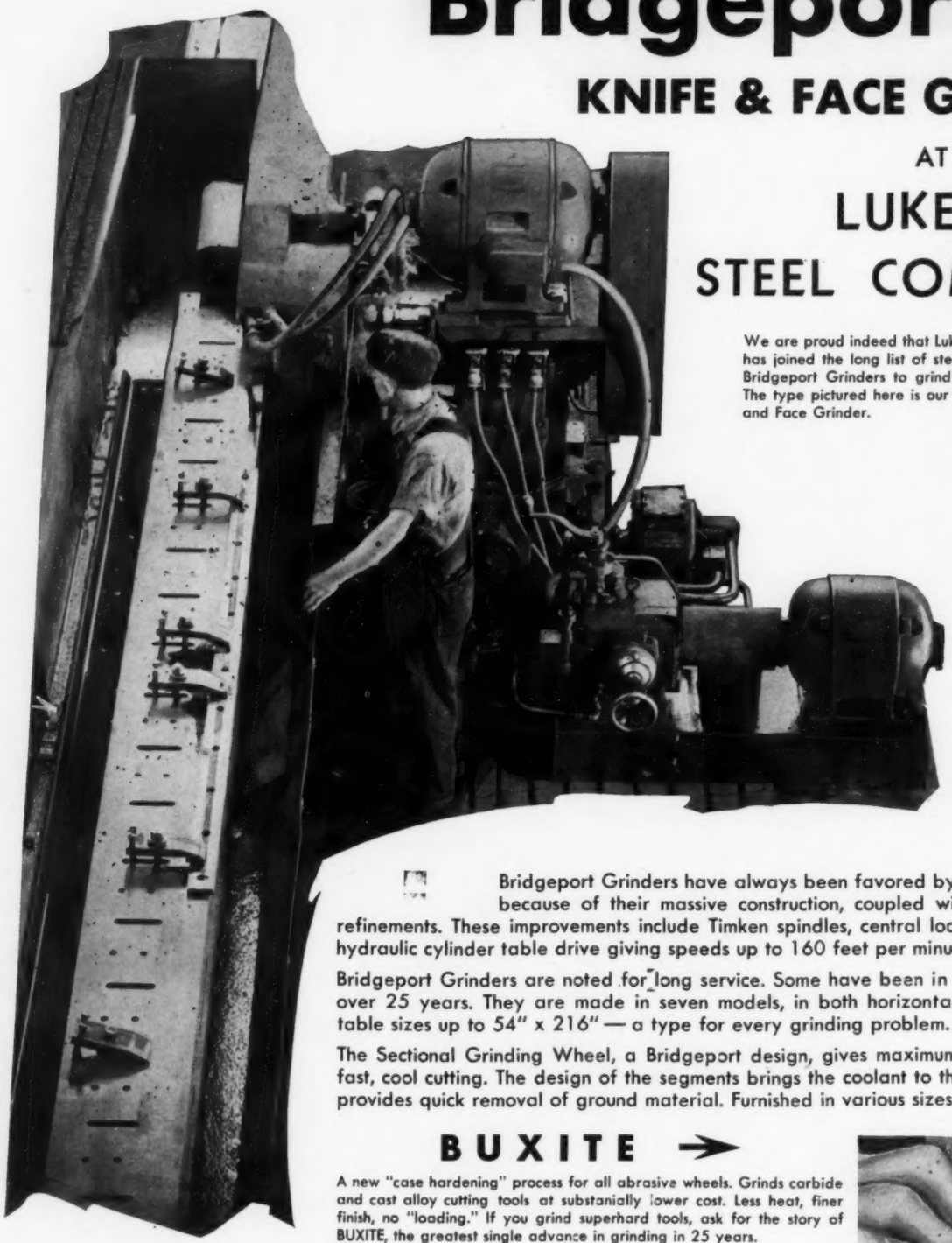
TOLEDO 1, OHIO

Bridgeport

KNIFE & FACE GRINDER

AT

LUKENS STEEL COMPANY



We are proud indeed that Lukens Steel Company has joined the long list of steel plants now using Bridgeport Grinders to grind their shear knives. The type pictured here is our No. 75-216" Knife and Face Grinder.

Bridgeport Grinders have always been favored by the steel companies because of their massive construction, coupled with the most modern refinements. These improvements include Timken spindles, central location of all controls, hydraulic cylinder table drive giving speeds up to 160 feet per minute, and many others.

Bridgeport Grinders are noted for long service. Some have been in continuous operation over 25 years. They are made in seven models, in both horizontal and vertical types, table sizes up to 54" x 216" — a type for every grinding problem.

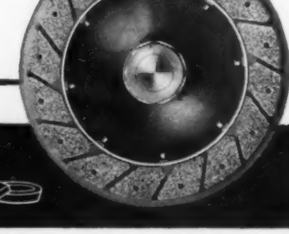
The Sectional Grinding Wheel, a Bridgeport design, gives maximum stock removal with fast, cool cutting. The design of the segments brings the coolant to the cutting edges and provides quick removal of ground material. Furnished in various sizes.

BUXITE →

A new "case hardening" process for all abrasive wheels. Grinds carbide and cast alloy cutting tools at substanially lower cost. Less heat, finer finish, no "loading." If you grind superhard tools, ask for the story of BUXITE, the greatest single advance in grinding in 25 years.

THE BRIDGEPORT SAFETY EMERY WHEEL CO., INC., BRIDGEPORT, CONN., U. S. A.

Bridgeport



GRINDERS • GRINDING WHEELS • BUFFING LATHES

•CRANE GEARS *Flame* HARDENED •••

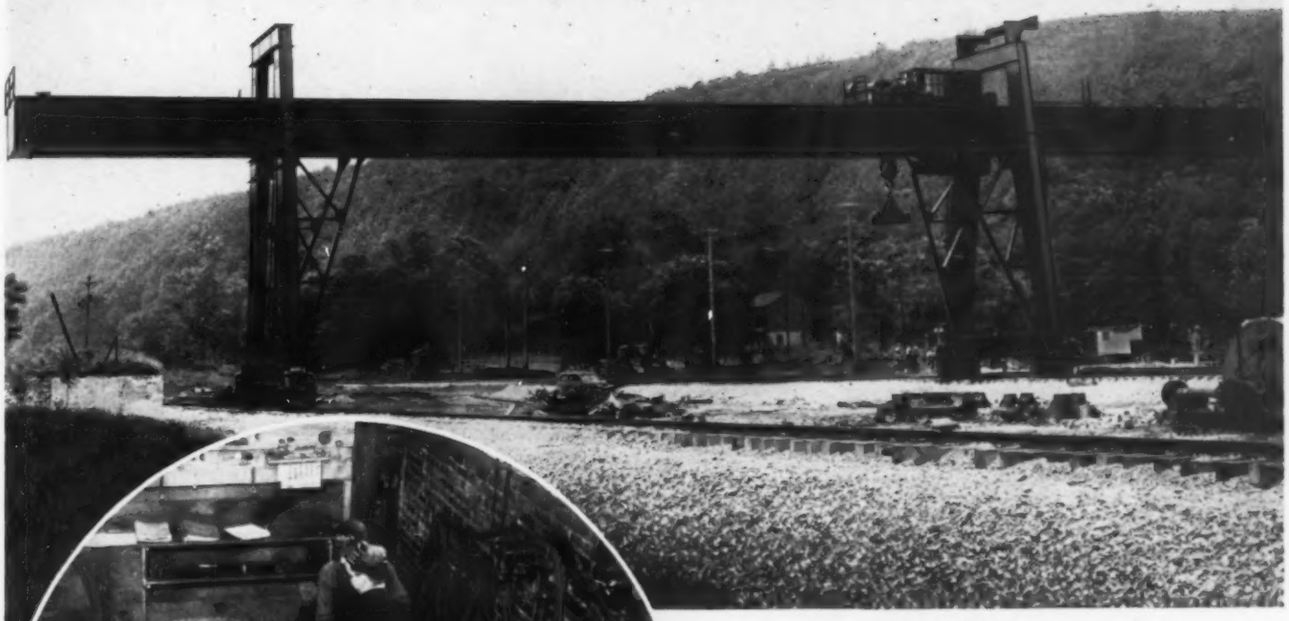


Photo courtesy of Alliance Machine Company

THE strength and hardness of NELOY steel castings for crane gears result from a combination of alloying and special hardening. The desired hardness, together with increased strength for specified requirements, result from careful control by National-Erie metallurgists. NELOY castings meet with outstanding success because they are giving excellent service in many varied applications . . . on overhead traveling cranes, in rolling mills and steel works equipment, power shovels, drag lines, and other machinery.

HERE ARE THE QUALITIES OF NELOY FLAME HARDENING

1. No sharp line of demarcation between the case and the core nor quick change in chemical analysis as with case hardened material.

2. The surface material depends not on hardness alone, but combines high hardness and toughness to resist wear and impact.

3. A core value that is equal to that of alloy steel, offering fatigue or impact values much higher than the regular case hardened product.

4. Hardened depth for necessary wear resistance equal to case hardening treatment at about one-third the cost.

5. A surface that will not spall with vibration or impact.

Write for Your Copy of New Bulletin No. 7

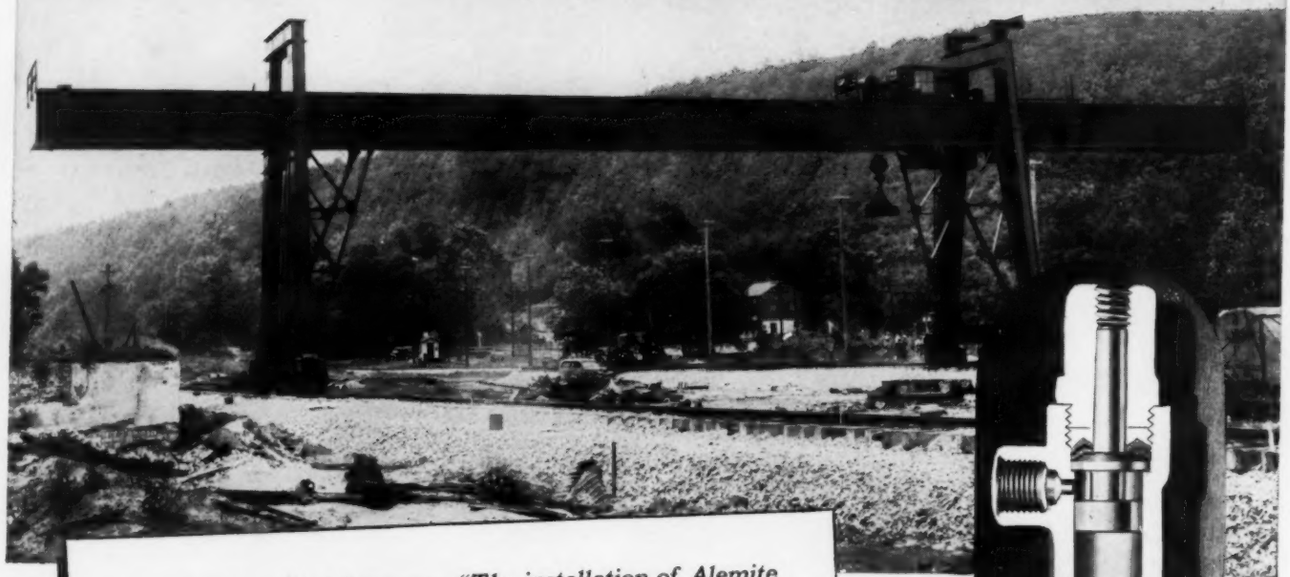
NATIONAL ERIE CORPORATION

ERIE, PENNSYLVANIA • U. S. A.

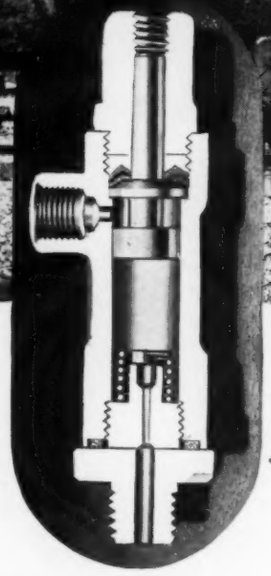
AT LUKENS STEEL COMPANY

84 Overhead Cranes Equipped with

ALEMITE LUBROMETER CENTRALIZED LUBRICATION SYSTEMS



Says Lukens Steel Company, "The installation of Alemite LubroMeter Systems on 84 overhead cranes eliminated human error, increased the safety of oilers and reduced lubrication time from 1½ hours to 10 minutes per crane."



Alemite LubroMeter Feeder Valve

Fully hydraulic • Only 2 moving parts • Indicator on each valve • Lubricant delivery easily adjustable • Valve is of heavy duty construction with hardened steel piston. Available in a variety of sizes and types.

The Alemite LubroMeter System is a single line terminating system with the valves mounted directly in the bearings. It handles grease or oil and is extremely economical in initial cost, installation and operation.

It is adaptable to practically every type of light and heavy machine used in the steel industry. Cranes, straighteners, tables, shears, blast furnaces, blooming mills, structural mills, rolling mills, levelers, etc. And the LubroMeter System can be installed for manual or automatic operation on present equipment, or built into new machines as original equipment.

There Are 4 Alemite Systems

. . . the LubroMeter and 3 other types. Have an Alemite Lubrication Specialist demonstrate one or all four Systems right at your desk with transparent working models. Call the Alemite Distributor nearest you, or write Alemite, 1895 Diversey Parkway, Chicago 14, Illinois.

ALEMITE HELPS THE WORLD GO ROUND

Another Product of STEWART WARNER

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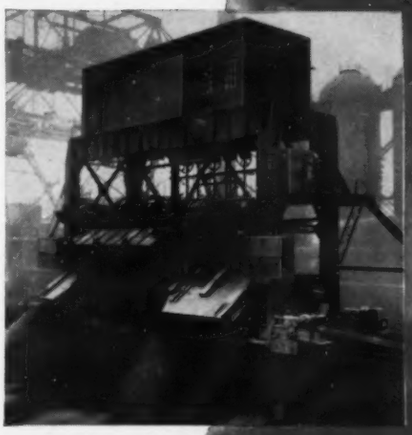
Alemite ALONE Combines all 3 in Lubrication

1. EQUIPMENT 2. PROCEDURES 3. LUBRICANTS

Modern Blast Furnace Equipment

uses TIMKEN BEARINGS

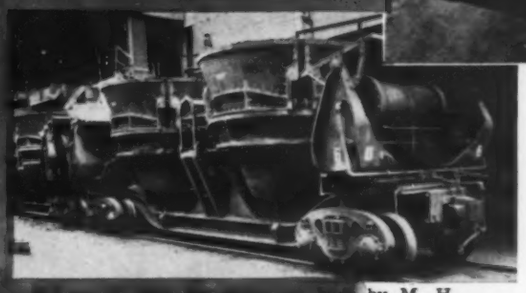


Travelling Railroad Car Dumper built by Heyl & Patterson, Inc., Pittsburgh, Pa.

Here are some outstanding examples of modern blast furnace equipment equipped with Timken Tapered Roller Bearings. Timken Bearings also are used in leading makes of skip cars; ore bridges; roll wheels; and bell hoists. Specify them for your product—and insist on seeing the trade-mark "TIMKEN" on every bearing you use.

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

160 ton mixer type hot metal car built by M. H. Treadwell Company, Inc., New York.



by M. H.

22-25 net ton capacity ore bucket manufactured by Blaw-Knox Co., Pittsburgh, Pa.

Pedestal-mounted clay gun manufactured by Edgar E. Brosius Company, Pittsburgh, Pa.

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Only J-M FIREBLOK offers all these advantages

Lighter Weight. Although more than five times the size of an ordinary fire brick, a Fireblok weighs practically the same.

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Larger Size. You can measure this advantage of J-M Insulating Fireblok with a yardstick! Because it is 5 times larger than ordinary brick, installation is faster . . . furnace downtime is cut to a minimum.

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JM-20 Fireblok for use up to 2000°F. Exposed or back-up.

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JOHNS-MANVILLE *First in* INSULATIONS

ElectroniK
Plus
RADIAMATIC

for Accurate
PRODUCT TEMPERATURE MEASUREMENT

At Lukens Steel Company, Coatesville, Pa., Brown *ElectroniK* and Radiamatic Pyrometers are helping in the accurate control of production temperatures.

Shown above is a Brown *ElectroniK* Strip Chart Potentiometer and Radiamatic measuring plate temperatures at the table of the 112" mill. Brown ElectroniK Potentiometers plus Radiamatics are especially well suited for such applications.

In the same way, Brown Radiamatics measure steel temperatures in some of Lukens' Continuous Normalizing Furnaces and soaking pits.

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The merits of "Continuous Balance" have been thoroughly proved during the last five years by thousands of installations which have enabled engineers to apply newest laboratory theories to faster production and higher quality.

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BROWN *ElectroniK* POTENTIOMETERS

Thirty Years
1916 · 1946

Since 1916, when Amsler-Morton was established, many men and women have contributed hard thinking and hard work to the AMCO organization today. A word of high appreciation to them all!

And, to our customers who have provided the opportunities for profitable service, so often repeated during those Thirty Years, our warmest thanks.

The making and forming of steel is a rugged business, but those who rely exclusively on the strong back soon fall behind. Strength must be guided by thinking, by ingenuity, by engineering.

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Designed and Built by

AMSLER-MORTON

Division of Union Industries, Inc., Pittsburgh, Pa.

FOR LUKENS STEEL CO.

COATESVILLE, PA.

Under U.S.A. Patents Listed Below:

2,092,402	2,232,281	2,271,776
2,235,048	2,287,645	2,138,886
2,354,330	2,223,635	2,245,057
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And other Patents Pending

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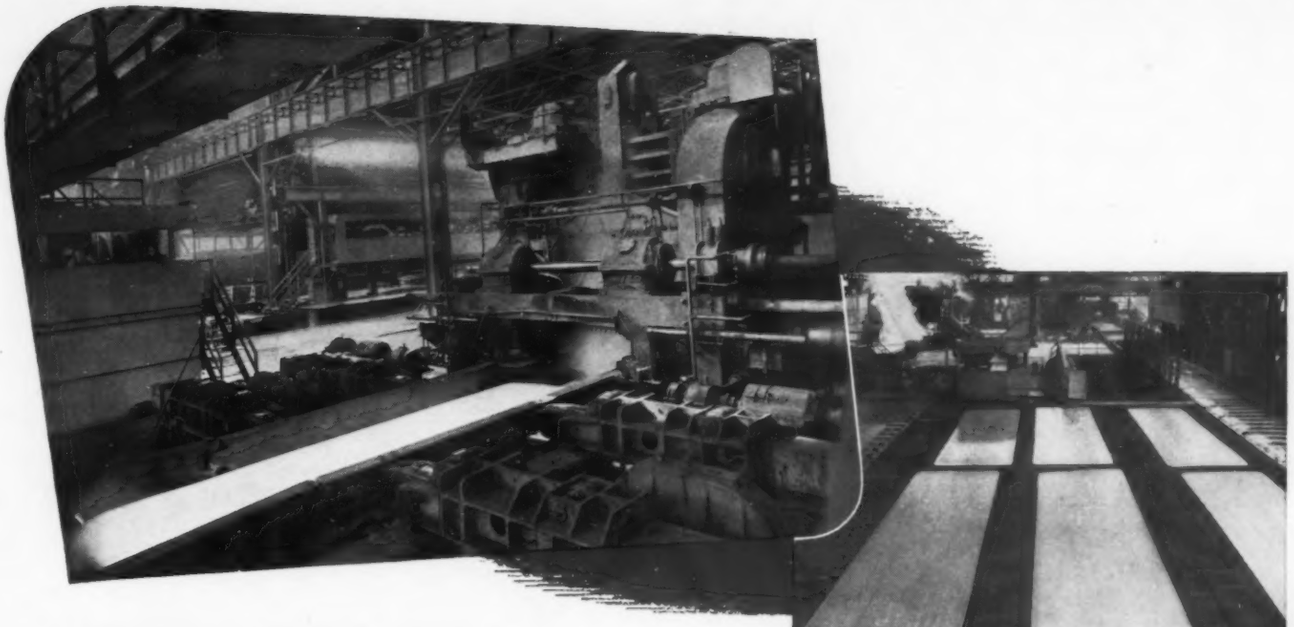

CLEVELANDS AT LUKENS STEEL COMPANY

Lukens Steel Company bought its first Cleveland Worm Gear Speed Reducers to drive Conveyors, in 1926.

Also in the new 120″ Mill Cleveland Worm Gear Units and Speed Reducers are driving Ingot Buggies, Screwdowns, Tilting Mechanisms, Edgers, Tables, Transfers, Turnovers, Shears, Levellers, Cranes and other equipment.

Thus Cleveland upholds its record throughout the Steel Industry—repeat orders based upon consistent, trustworthy performance in tough spots. Cleveland made its first installation 29 years ago—many of the earliest Units are still operating, and modern Clevelands are serving almost every Mill application.

The Cleveland Representative will help to make this unique experience profitable to you, in selecting and specifying new Drives for *your* Mill. The Cleveland Worm & Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication
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CLEVELAND
WORM GEAR *Speed Reducers*

FARVAL on the world's largest Plate Mill

PROGRESSIVE, 136-year-old Lukens Steel Co., turns to Farval for positive lubrication of the 206″ mill stand shown above—largest Plate Mill in the world. Continuous operation is thus assured, with no need for shutdowns to lubricate.

In addition, Farval Centralized Lubricating Systems have been installed on the 112″ and 120″ Plate Mills at Lukens. Cranes, Tables, Turnovers, Transfers, Shears and Pilers are likewise Farval-equipped.

There are more Farval Systems installed on Steel Mill equipment than all other makes combined. Positive lubrication can reduce *your* operating costs, too. Your nearby Farval Representative has valuable information for you.

The Farval Corporation, 3278 East 80th Street, Cleveland 4, Ohio.

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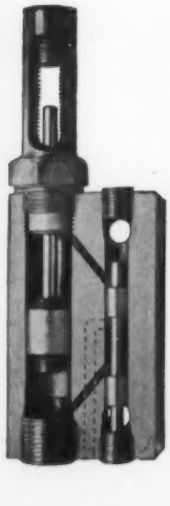
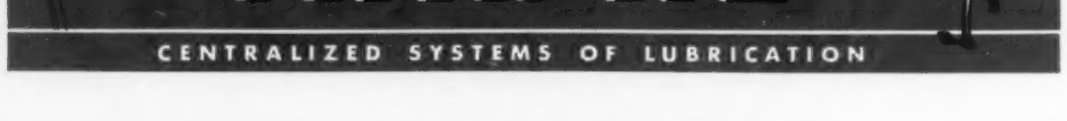


Farval—the Dualine System with the Positive Piston Displacement Valve—that has but 2 Moving Parts—is Fully Adjustable—with a Tell-tale at each bearing to show the job is done.



Electrical Power Supply

FOR STEEL MILL LOADS

. . . . few people not connected with the steel industry realize the extent of its power demand . . . . the following paper describes the selection of a power system for a steel plant and the factors on which it is based . . . .

by F. W. Cramer, ELECTRICAL ENGINEER
CARNEGIE-ILLINOIS STEEL CORPORATION
PITTSBURGH, PENNSYLVANIA

▲ A REPORT of the Federal Power Commission dated July 1945, on the subject "Industrial Electric Power in the United States" contains the following statistics showing the relative importance of steel mill electric power loads, in the year 1944:

Total electric power generation in U. S. A.	279,500,000,000 kwhr
Used by manufacturing and extracting industries	158,800,000,000 kwhr

The major users of this power were:

a. Chemicals	29,163,000,000 kwhr
b. Iron and steel	23,290,000,000 kwhr
c. Non-ferrous metals	20,755,000,000 kwhr
d. Paper	11,037,000,000 kwhr
e. Transportation	8,908,000,000 kwhr
f. Textiles	8,815,000,000 kwhr

The above figures show that the steel industry was the second largest consumer of electric power in the above classification and 8.3 per cent of the total power and 14.7 per cent of the industrial power in the U. S. A.

In the year 1944, there were produced in the U. S. A. 89,550,000 tons of steel ingots, which with the above power consumption shows an average of 261 kwhr used per ton of ingots produced. In 1939, 52,800,000 tons of ingots were made with a consumption of 12,245,000,000 kwhr or an average use of 232 kwhr per ton. This comparison indicates the effect of the large electric furnace installations which require about 650 kwhr to produce a ton of steel ingots plus the increased electrification of processes made during the emergency.

The above figures are for the steel industry and are greater than those from the individual steel producing plants excepting those plants where the major steel making units are electric furnaces. A modern integrated plant with coke ovens, blast furnaces, primary and secondary mills including a wide strip mill, which also sells semi-finished and heavy products will have an average electric power consumption of from 125 to 175 kwhr per ton of ingots.

Before discussing a power supply for these steel mill electric loads, the type and possible magnitude of some of the composite parts making up the total should be investigated.

TYPE OF LOADS

The electric power loads from coke plants and blast

Presented before the Midwest Power Conference, Chicago, Illinois; April 5, 1946.

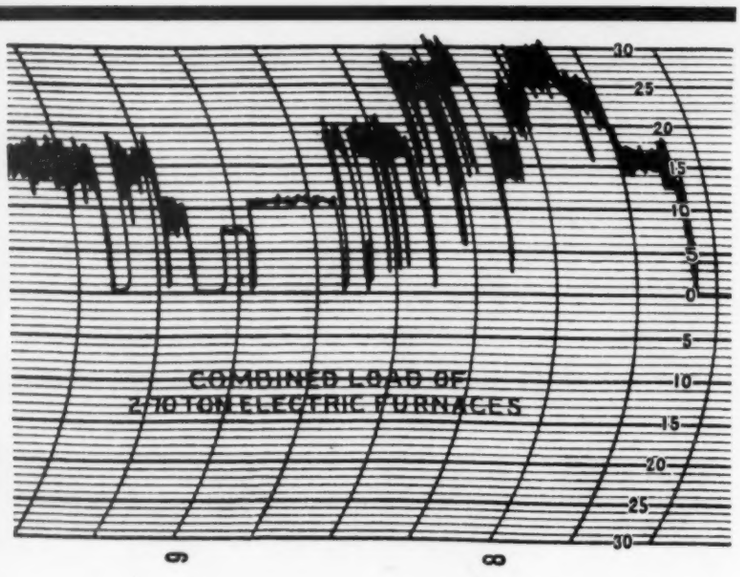
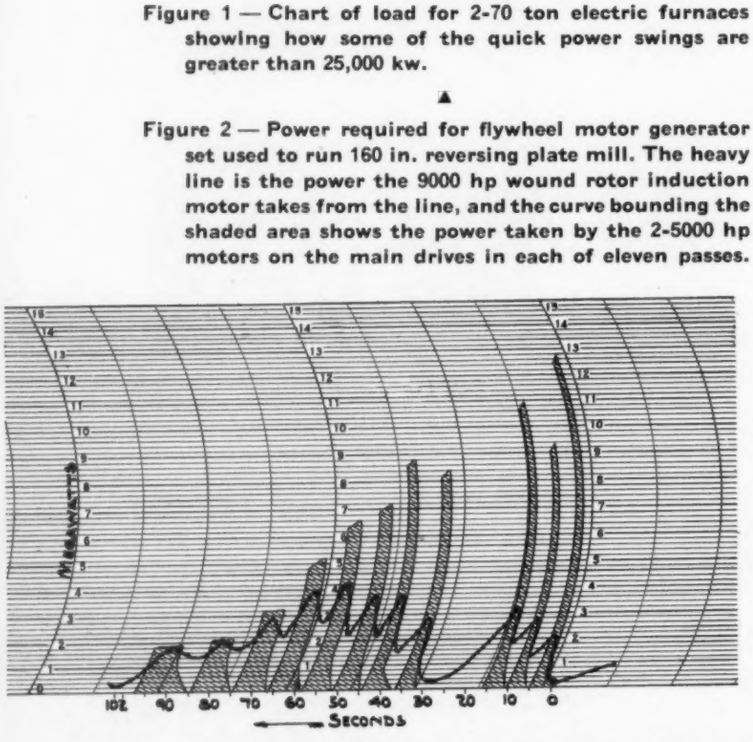


Figure 1 — Chart of load for 2-70 ton electric furnaces showing how some of the quick power swings are greater than 25,000 kw.

▲

Figure 2 — Power required for flywheel motor generator set used to run 160 in. reversing plate mill. The heavy line is the power the 9000 hp wound rotor induction motor takes from the line, and the curve bounding the shaded area shows the power taken by the 2-5000 hp motors on the main drives in each of eleven passes.



furnaces are fairly constant and will be discussed later. In the steel making division, the electric furnaces create a peaking type swinging load that has quite a bearing on the power supply. At the present time, an annual capacity of close to 8,000,000 tons of ingots per year has been installed for this type of melting. Many of these furnaces have 10,000 to 15,000 kva in transformer capacity which is required during the melting period. Figure 1 shows the type and extent of the power load from 2 - 70 ton furnaces. Some of the quick swings on this particular chart are greater than 25,000 kw. Scheduling of heats, special controls, and care in placing the scrap in the furnaces help reduce these swings, but results like those shown on the chart are representative of this type of loading.

After the steel has been made and cast into ingots, it goes to the primary mills to be reduced to blooms or slabs. These mills are usually driven by direct current motors up to 10,000 hp in size which receive their power from induction motor driven flywheel generator sets. Since the load duration is short, the flywheel absorbs the peaks so that the load on the power system is limited to some 6000 kw. Figure 2 shows this type of loading. The shaded sections show the power taken by the main drive d-c motors, while the heavy line shows the power taken by the wound rotor induction motor from the line.

The blooms and slabs from the primary mills are then taken to the finishing mills where they are reheated and further reduced. The modern sheet and tin mills, which produce the flat products, have as their primary reduction unit a wide strip mill. There are 28 of these mills now in operation with total capacity of driving motors on the largest mill of 42,500 hp. As the slabs are processed through the continuous stands, the total load is built up with a result as shown in Figure 3. In this chart, the system load was increased from 800 kw to 24,500 kw in 10 seconds and decreased from 22,000 kw to 1200 kw in 7 seconds. This is a typical curve and does not represent the maximum conditions.

The foregoing are loads that the power system in steel mills must supply. They are far different from the usual loads in utility systems.

In order to present a more concrete example of the power requirements and supply for a modern steel mill, a modern integrated plant with an annual production of 1,500,000 tons of ingots, and finishing capacity as outlined below will be used as an example. These 1,500,000 tons of ingots will be rolled into semi-finished and finished products as shown in the table below. Electric furnace production and wide strip mills have been omitted from the table in order to simplify the problem of power supply from waste fuels available in the plant.

Product	Product, tons	Blooms, billets or slabs required	Ingots required, tons
Bars	421,000	465,000	581,000
Plates	244,000	290,000	342,000
Structurals	178,000	200,000	235,000
Rails	175,000	195,000	230,000
Track accessories	37,000	45,000	57,000
Wheels	34,000	40,000	55,000
Total	1,089,000	1,235,000	1,500,000

To produce the above products, the following rolling mills will be required:

a. Blooming and slabbing mill
b. Billet mill
c. 12 in. Bar mill
d. 16 in. Bar mill
e. Structural and rail mill
f. Reversing plate mill
g. Wheel mill
h. Splice bar and mine tie plant

The ingot tonnage shown in the above table will all be reduced in the combination blooming and slabbing mill which will result in an annual production of 1,235,000

tons of blooms and slabs. These are then assigned to the various secondary and finishing mills to produce the product mix required. In this example, the following annual production is assumed.

	Blooms or slabs required, tons	Product, tons
Billet mill	510,000	458,000
Structural and rail mill	395,000	353,000
Plate mill	290,000	244,000
Wheel mill	40,000	34,000

From the billet mill the following billets will be used on the merchant mills to be rolled into the finished products.

	Billets, tons	Product, tons
10 in. Bar mill	245,000	221,000
16 in. Bar mill	220,000	200,000
Splice bar and mine tie	45,000	37,000

With the production of the various rolling mills established and the ingot tonnage determined, the iron and coke requirements can be calculated. These calculations are part of the power study in that both the coke and iron production have gaseous fuels as a by-product which can be used in the production of electric power, and in metallurgical processes.

The quantities of iron required for ingot production varies in different locations and in different shop practices, and is affected by the price of scrap.

The amount of coke to produce a ton of iron also varies with many factors including the grade of ore and the analysis of the coke.

The amount of coal required per ton of furnace coke produced and the resultant by-products also varies.

For the above reasons, the data used in the following example, which was normal practice in one plant, would have to be checked before using at other locations.

Basic data:

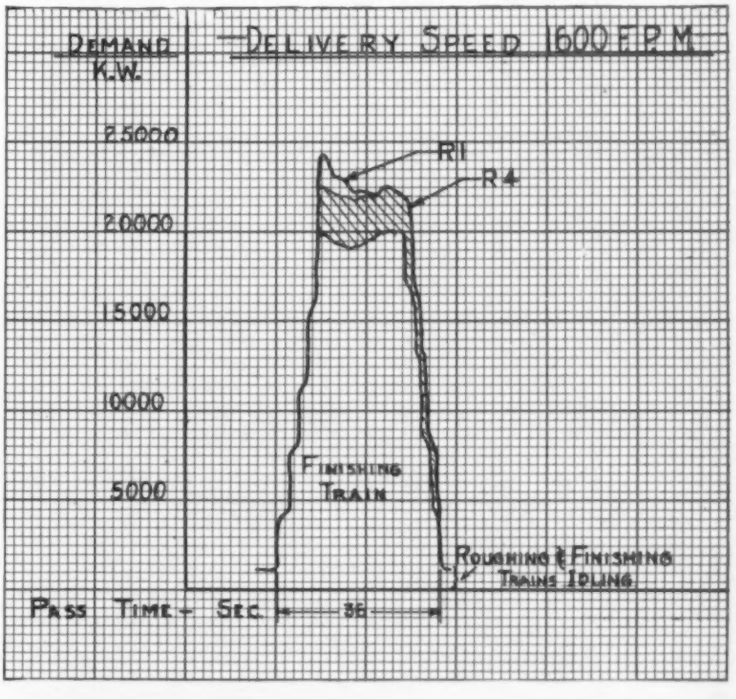
1. Ingot production — 1,500,000 tons per year = 125,000 tons per month. This will require ten or eleven 225 ton open hearth furnaces.
2. Ratio of ingots to metallic charge in the open hearth is 0.9. Metallic charge per month = 125,000 ton ÷ 0.9 = 138,800 tons.
3. Hot metal charge in open hearth = 60 per cent of metallic charge = 0.6 × 138,800 = 83,328 tons, which is the iron from the blast furnaces.
4. For each ton of iron produced in the blast furnaces, there will also be produced 10,500,000 Btu in gas. This gas has a heating value of about 90 Btu per cu ft. The production of 83,328 tons of iron per month will therefore produce 874,974 millions of Btu in the by-product gas.
5. For heating the stoves, blowing the furnace and losses, 36 per cent of this gas will be needed, leaving 64 per cent or 559,964 millions of Btu available for producing steam and electric power and other heating.
6. Modern steel mill power houses will produce a kwhr with 14,500 Btu of blast furnace gas as fuel. On this basis there could be generated each month from this unstorable by-product fuel 38,400,000 kwhr. Based on a 720 hour month this represents an average generation of 53,300 kwhr.
7. To produce this 83,328 tons of iron will require 1650 pounds of coke per ton or 68,845 tons of furnace coke per month, or 826,000 tons per year.
8. If the ratio of furnace coke produced to coal charged into the ovens is 66 per cent, then 101,000 tons of coal per month are required to charge the ovens.
9. In general, such a coke plant will have, as a by-product of furnace coke production, sufficient coke breeze to generate all of this unit's steam and electric power requirements.

In this study, it is assumed that the 500 Btu coke oven gas will be used for metallurgical purposes and not used under boilers. It is also assumed that the coke breeze available will be used for miscellaneous steam requirements.

Having determined the coke and iron requirements, the assigned tonnages of the various producing and rolling units, the electric power consumption of the assumed plant can be estimated together with the peak demands. Data on the kwhr consumption for the various operations in such a plant may be found by comparison of data from many existing plants and in the publications of the Association of Iron and Steel Engineers.

The annual estimated power requirements based on the previous assumptions are as follows:

Figure 3 — Simultaneous demand of main drives of continuous hot strip mill when rolling 6 in. × 40 in. × 105 in. slabs to 0.060 in. × 48¾ in. × 702 ft.



Mill or department	Annual production in tons	Kwhr per ton	Total kwhr
Coke plant	826,000	17	14,042,000
Blast furnaces	1,000,000	10	10,000,000
Open hearth	1,500,000	8	12,000,000
Blooming mill	1,235,000	26	32,110,000
Billet mill	458,000	28	12,824,000
Wheel mill	34,000	110	3,740,000
12 in. Bar mill	221,000	65	14,365,000
16 in. Bar mill	220,000	55	11,000,000
Structural and rail mill	353,000	60	21,180,000
Plate mill	244,000	87	21,228,000
Splice bar and mine tie	37,000	70	2,590,000
Miscellaneous pumps, shops, compressors, lighting, etc.	Avg load 7000 kw × 8760 hours		61,320,000
Total			216,399,000

The above total represents an average consumption of 18,000,000 kwhr per month. Previously it was shown that there would be blast furnace gas available to generate 38,400,000 kwhr per month, hence so far as average loads are concerned, this plant can generate all electric power requirements from a by-product fuel that would otherwise be wasted.

The next step in the process is to estimate the 15 minute peak demand on the system. This is done by a combination of several methods. Steady loads like the miscellaneous, coke plant, blast furnaces and open hearths have a ratio of about 0.9 of peak load to average. The rolling units when operating full have rather definite peak loads which are determined by the size of the equipment and the rolling schedules. After a summation of all the peak loads is made, a diversity factor has to be used to estimate the combined load or the total system peak. For this particular problem, the following tabulation shows one method of estimating this total.

Mill or department	Annual kwhr	Working hours per year	Avg kwhr per operating hr	Ratio avg load to peak	15 min demand, kw
Coke plant	14,042,000	8,760	1,590	0.9	1,770
Blast furnace	10,000,000	8,760	1,150	0.9	1,280
Open hearth	12,000,000	8,760	1,370	0.9	1,520
Blooming mill	32,110,000	7,488	4,300	....	5,400
Billet mill	12,824,000	5,000	2,550	....	4,000
12 in. Bar mill	14,365,000	5,500	2,620	....	3,500
16 in. Bar mill	11,000,000	5,300	2,080	....	3,000
Structural and rail mill	21,180,000	5,000	4,220	....	5,000
Plate mill	21,228,000	4,000	5,300	....	6,500
Wheel mill	3,740,000	4,500	830	....	1,000
Splice bar and mine tie	2,590,000	4,500	575	....	650
Miscellaneous	61,320,000	8,760	7,000	0.9	7,800
Total			33,565		41,420

If we apply a diversity factor of 0.9 to the rolling mill loads, this total is reduced about 3000 kw, which results in an expected 15 minute demand of 38,420 kw. This gives a ratio between the week day average power consumption and the 15 minute peak of 87.0 per cent. The figures also show an average kwhr consumption per ton of ingots produced of 141.

Some plants use a figure showing the relation of the average hourly consumption which is the monthly consumption divided by 720 hours, to the 15 minute demand. In this example this average hourly consumption is at a rate of 24,600 kw and the ratio to 15 minute demand 64 per cent. On a purchased power basis this would represent 460 hours use of the demand.

Having determined the amount of the electric load and the availability of unstorable blast furnace gas, the problem of supplying this power becomes one of economics.

The data developed shows that at capacity operations, the available blast furnace gas will produce 53,300 kwhr. Uses for the remainder of this gas would be analyzed in the fuel balance that would be made up in a companion report when the assumed plant was being engineered.

If we assume that normal operations of this plant are 80 per cent of capacity, it would produce 80 per cent of this available gas or sufficient to generate 43,000 kw average. The peak demand however, would approximate 90 per cent of the capacity demand or 34,500 kw.

How to supply this load is the next problem to be analyzed.

In starting this analysis, some rough estimates on amount of money that can be justified for investment in power producing facilities will serve as a guide.

For 80 per cent capacity operations there will be required 172,000,000 kwhr. We will assume this can either be purchased or generated. If purchased, let us assume the average price will be $7.00 per 1000 kwhr. On this basis, the annual bill would be $1,204,000.

Now a modern steel mill power house has an operating cost, without fuel, which in this case is one which otherwise would be wasted, of about $0.55 per 1000 kwhr. This does not include taxes, depreciation, or insurance. For these, we can assume 11 per cent of the investment. In addition to this, a return on the investment of 12½ per cent should be attractive. From these figures the following deductions can be made:

1. Cost of purchased power	$1,204,000
2. Cost of operations, without fuel, of power house	94,600
Difference	$1,109,400
Depreciation, taxes, etc. 11 per cent	
Return on investment 12½ per cent	
Total 23.5 per cent of investment =	$1,109,400
Maximum investment =	$4,700,000

There are at least 3 schemes of providing generating capacity. The estimating figures used are based on those for 1939, since present day prices for labor and material are too unsettled to get comparisons.

1. Install a single 40,000 kw turbo-generator with one boiler, and distribute at generator voltage of 13,800. This plant could be built for $90.00 per kw. It would, however, require a standby service from a utility to the extent of 25,000 kw which would cost about $450,000 per year. This combination, allowing $200,000 for the cost of installing utility connection, would cost:

$90.00 × 40,000 kw	$3,600,000
Utility connection	$ 200,000
Total	$3,800,000
Operating cost of station (excluding fuel)	$ 94,600
Utility cost	450,000
Total expense	$ 544,600
Cost of all power purchased	$1,204,000
Operating costs, scheme 1	544,000
Left for taxes, depreciation, return on investment, etc.	$ 680,000

= 17.4 per cent of investment,

2. Install two 20,000 kw turbo generators with two boilers and distribute at generator voltage.

At 1939 prices, this plant would cost about $110.00 per kw installed or $4,400,000. Operating costs would be about $10,000 more per year than the single unit or roughly $104,600 per year. Then if compared with cost of purchased power

Cost of purchased power	$1,204,000
Operating cost of station (excluding fuel)	104,600
Left for depreciation, taxes, return on investment, etc.	$1,099,400

= 25 per cent of investment.

3. Install three 12,500 kw units with three boilers and distribute at generator voltage.

On the same basis as previously used, this plant would cost about $125.00 per kw installed or a total of $4,690,000. The operating cost would be about $7,500 per year above the two unit plant, or a total of $112,100 per year. The comparison in this case becomes:

Cost of purchased power	$1,204,000
Operating cost of station (excluding fuel)	112,100
Left for depreciation, taxes, etc.	$1,091,900

= 23.4 per cent of investment.

These rough approximations would indicate that a power house with two 20,000 kw units would give the best return on the investment. Turbine outages other than the planned inspections are rather small, and with these two units operations would be planned so that an outage would have the least effect on production.

The operation referred to in the above study is typical of any integrated steel plant without electric furnaces or wide strip mills. The available blast furnace gas, which due to its low heat content can best be used under boilers near the point of production and transformed into electric energy which can be transported long distances, is more than sufficient to supply the electric plant load.

There is another combination that has been worked out in a few cases. Blast furnace gas is an unstorable fuel and must either be used as produced or wasted. The production of this gas is rather constant for a given furnace operation and is continuous 24 hours a day, seven days a week. This means that due to the variable power load there is wastage in the load valleys or if other consumers have been found for the gas, it necessitates burning oil or coal to furnish power for the peaks.

In the instances referred to, an arrangement was made with a utility to interchange power on a basis of economic advantage to both parties, which resulted in an installation of only one turbine and one boiler in the steel mill power house and the excess steel mill power was taken by the utility at a rate satisfactory to both parties.

In the previous discussion, large electric furnace loads and those from the wide strip mills were eliminated. A common war time installation of electric furnaces had a demand of some 25,000 kw. However, during melt-down periods, where two and perhaps three furnaces were melting at the same time, the quick swings due to the 20 inch electrodes making or losing contact with the scrap would at times approximate 35,000 kva. On single or two turbine operation, it is not possible for the machines to handle this rapid rate of rise or decline and wide fluctuations on frequency and voltage result.

Practically all of these installations have been connected to large utility systems where the swings could be absorbed by a number of generators and have little effect on the system.

The wide strip mills have the same type of quick swinging loads, and although some few of these mills are supplied from isolated systems, the great majority have a utility connection.

In concluding this brief paper on power supply for steel mill loads, the reason for steel mills with blast furnace production being in the power business is repeated as follows:

These furnaces produce quantities of low heating value gas that cannot be stored or transmitted economically long distances and furthermore is not suitable for many metallurgical operations. It does make a good boiler fuel and steam can be transformed into electric energy that can be transmitted to points of usage. It is good business for steel companies to utilize this gas, which is common practice, but normal power requirements in excess of the amount that can be generated by this unstorable fuel are often purchased from power companies.

Carbon Products

IN THE STEEL PLANT

. . . . the use of carbon instead of ceramic linings in blast furnaces and in other steel mill applications has many possibilities . . . . some recent applications are described in the following paper . . . .

by Frank Vosburgh

NATIONAL CARBON COMPANY

NEW YORK, NEW YORK

▲ OVER the years carbon and graphite have played an important but unpublicized part in the iron and steel industry. Those who operate electric steel furnaces appreciate best the unusual qualities of carbon, but even they have thought of it chiefly as a means for getting power into the furnace.

It is strange that only in the last ten years has real advantage been taken of a material having qualities that should make it extremely valuable for many purposes. At this late date it is hard to say why that has been so. Perhaps the carbon manufacturers have not been forceful enough in presenting the good qualities of carbon to the iron and steel industry, or it may have been the disinclination of that industry to experiment with an unfamiliar material, There has been a change of attitude today and the two industries are co-operating in a way that must result in mutual good.

Chronologically, the oldest recorded use of carbon in which the ferrous industry has any great interest was in crucibles made from a mixture of natural graphite and clay, a use that dates back to early in the 19th century and which reached its peak during World War I, but is now of relatively small consequence because of the advent of the electric furnace. Just how early in history this application appeared does not seem to be known.

Apparently the next recorded use of carbon is as a furnace lining material. It was a Scot, Henderson of Glasgow, who, early in the eighteen sixties first took advantage of the unusual qualities of carbon and lined the hearth of a ferromanganese furnace with blocks probably made of retort carbon and tar, molded and baked.

Burger of Germany in 1886 was the first to try carbon in a blast furnace, though the furnace of his day was ill designed for the introductory use of carbon as a refractory. The experiment was reported in Stahl and Eisen in 1890 ("Carbon Linings for Blast Furnaces," by F. J. Vosburgh, A. I. S. E. Yearbook, 1940).

There were excellent reasons for using carbon in German blast furnaces. First, the refractories were relatively poor; second, the German ores were low grade with consequent large volumes of highly corrosive slags which were very hard on the refractories available.

Presented before the Birmingham and Pittsburgh Sessions of the Annual Meeting, September 17 and 26, 1945.

As a result, there was much experimenting with carbon brick and small blocks, many of which were made by the blast furnace people themselves and were of questionable quality. As mentioned previously, however, the furnaces were ill adapted to carbon use and the results varied from good to bad. In spite of this fact, the use increased until in 1939 when it is reported that 85 per cent of German iron was produced in carbon-lined furnaces.

All types of carbon linings were tried: bricks, large and small blocks and tamped paste. Carbon was put in the hearth only, hearth and side walls of the hearth section, and carried beyond the top of the hearth jacket clear to the mantel. Carbon was a "natural" for the application so long as it was not exposed to oxygen and carbon dioxide. Improvement in the construction of blast furnaces, particularly making the shells of the lower part of the furnace more nearly air-tight, helped to prevent the inward leakage of air and thus provide conditions suitable for the use of carbon.

The outstanding properties of carbon in this application are: (1) carbon is not affected by blast furnace slags, no matter how corrosive; (2) molten iron does not attack carbon, since if anything the iron carries an excess of carbon; (3) no temperature attained in blast furnace operation is high enough to affect the shape of carbon; (4) at the blast furnace's highest temperature the strength of carbon is equal to its strength at room temperature. These facts are not true of ceramic materials.

Compared with clay refractories, carbon products are to some extent relatively expensive because of the difference in cost of such raw materials as coal, petroleum coke and pitch, versus clay and water. Linings of carbon paste tamped into place hot are the cheapest form of carbon; at least the carbon paste itself is cheaper than formed and baked carbon blocks or bricks, but it is doubtful if the tamped carbon lining is sufficiently lower in cost than the brick or block lining to be of consequence.

No report can be made on German tendencies but certainly English operators, who until recently have used only tamped paste, are now turning to carbon brick. G. D. Elliot, superintendent of blast furnaces, Appleby-Frodingham Works of United Steel Companies, Ltd., has said in substance that when carbon paste bakes in, there are apt to be a few large cracks instead of many small ones and that while some have success with tamped-in linings, others have had serious run-outs.

The carbon brick, in sizes corresponding to the ceramics generally used, are next in cost, particularly the homemade variety carrying wide tolerances. The homemade variety are usually low in apparent density, low in strength and not too accurate in shape. However, if the brick are made in accordance with strict manufacturing standards they are therefore of much higher quality. The installed cost of such brick is higher than that for the large carbon blocks, especially if the user insists on close tolerances of $\frac{1}{32}$ - $\frac{1}{16}$ in. on all dimensions, as seems to be the tendency in the United States.

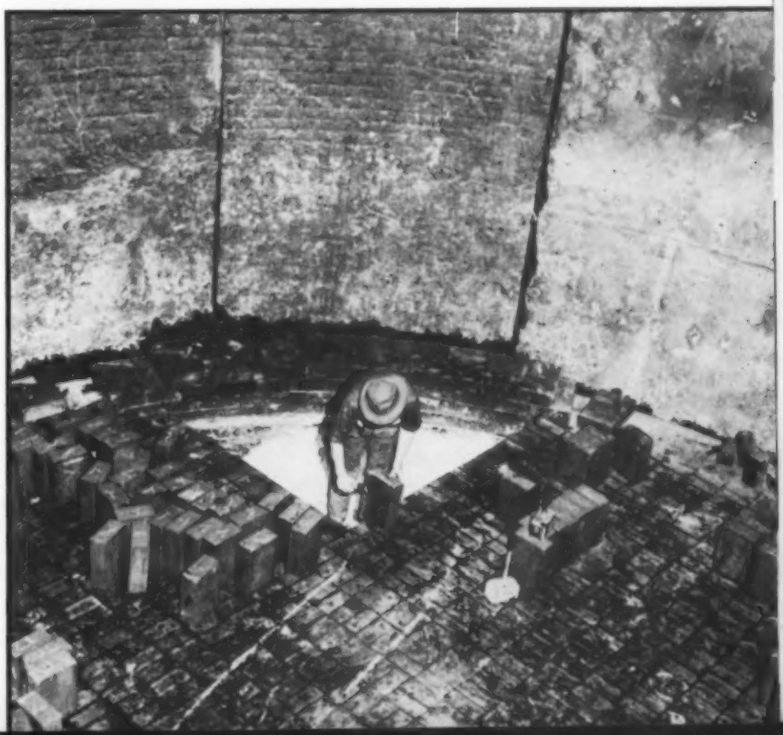
To a blast furnace operator the use of carbon brick or small blocks seems a logical step of development, but in taking that step he neglects or fails to realize the fact that carbon can be easily fabricated into blocks weighing 3 to 4 tons each. Such blocks are homogeneous from end to end and face to face, and are not subject to heat shock in spite of their size (See Figures 1, 2, and 3). Use of blocks in the largest possible sizes that can be handled easily cuts the number of joints from thousands to a few hundred. Laying a block that is the equivalent of as many as 1,000 – 9 in. straights is a much simpler and much quicker operation than laying that number of brick.

When large blocks are used for lining the furnace, those in the wall are machined so that butting faces, made up with carbonaceous cement, are tightly joined, for wide paste joints are not easily handled in the vertical position. It is recommended that joints between the hearth blocks be 1½-2 in. wide and filled with carbon paste tamped in hot. The carbon paste is the same material as that in the blocks and, upon baking in, makes a tight joint and produces a hearth of almost monolithic structure.

Some operators will undoubtedly prefer machined joints in the hearth despite the greater cost. Much can be said for each type of joint. Blast furnace operators are accustomed to tight joints when laying ceramic blocks, even requiring that the blocks be ground. On the other hand, for nearly forty years ferro-alloy furnace operators have used only wide joints when laying up the carbon blocks in their furnaces and rarely if ever attempt to use tight joints. Certainly ferro-alloy furnaces are as hard on refractories as blast furnaces.

Whereas it may be said that the carbon lining of a blast furnace for the hearth and hearth walls will be more costly than a clay brick lining, nevertheless the important factor is that if at the end of a campaign no salamander is found in the carbon lined furnace (this should be the case judging by the evidence available) then the extra cost of the carbon is of little consequence. Any comparison should include the cost of removing a

Figure 1 — Installation of carbon brick lining in a blast furnace.



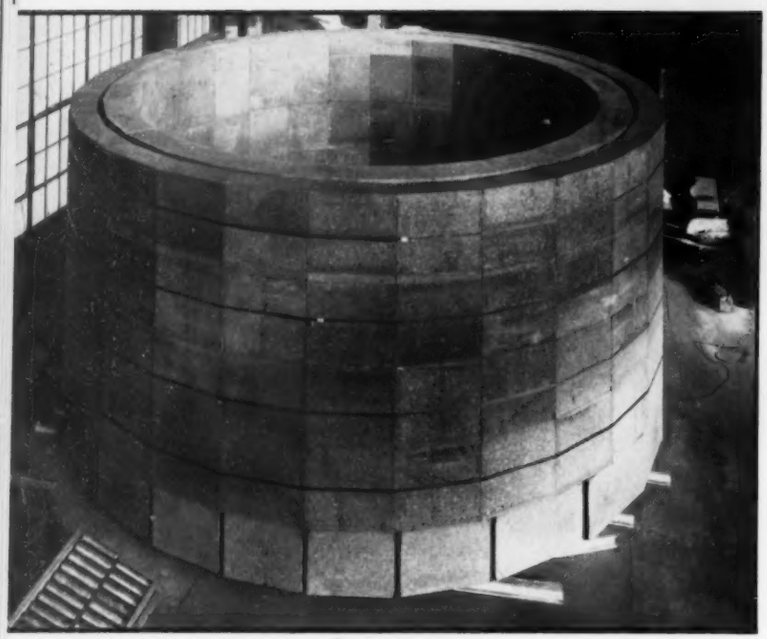


Figure 2 — Carbon block lining for a blast furnace assembled on a manufacturer's floor for inspection.

salamander weighing up to 1500 tons. When to that cost is added the value of 10 to 20 days of lost time at $1,000.00 or more a day, the carbon lining is cheap at almost any price. In addition, if run-outs are prevented, then a very important objective will have been attained.

Carbon linings will come close to being competitive on a dollar basis when the carbon is carried to the mantel, as is generally the case abroad, for then the higher cost of the carbon is offset by the cost of the cooling plates extending upwards from the top of the hearth jacket, a figure that makes up one-third to one-half of the cost of the ceramic lining. With the present antipathy of blast furnace operators to shower-cooling or anything remotely resembling it, that day may be a long way off but it will undoubtedly come.

Blast furnace operators have been slow to use carbon in their furnaces; in fact, up to 1937 practically no use had been made of it. In that year one superintendent tried out carbon paste in the hearth of a furnace. Since 1943 a great deal more interest has been shown in the material and as of August 1, 1945 progress has been as follows:

Hanna Furnace Company, Buffalo, New York has put layers of carbon paste in the hearths of two furnaces. Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania has installed one hearth and side wall lining, and has purchased a second lining of ceramic sized blocks. Interlake Iron Corporation, Duluth, Minnesota has purchased a carbon lining for hearth and side walls made of large blocks. Carnegie-Illinois Steel Corporation, Chicago, Illinois has installed in the hearth of one furnace a pad 36 in. thick of large blocks which run from shell to shell. National Tube Company, Lorain, Ohio, has ordered a carbon lining similar to the Carnegie-Illinois, Pittsburgh, lining. At least 3 other linings are being discussed as probabilities for 1946. Following close on the heels of the use of carbon for blast furnace lining in Europe came the use of carbon

Figure 3 — View into furnace showing hearth blocks and iron notch of a blast furnace carbon lining.

for lining electric ferro-alloy furnaces (Figures 4 and 5). In that application, the furnace operator practically had no choice, he had to use carbon and such is still the case. The alloy furnaces in which the steel producer is interested, that is, those in which ferrosilicon, ferromanganese and ferrochrome are made electrically, are with very few exceptions lined with carbon because that is the only material that will adequately resist the corrosive slags at the high temperature required for the production of the alloys. Such furnaces vary greatly in size from a few hundred horsepower to those of 25,000-30,000 horsepower in which calcium carbide is produced.

The period from the late nineties until after World War I marked a time of tremendous expansion of the uses of carbon and graphite, although primarily as electrodes for electric furnaces of all kinds, and for the various types of electrolytic cells which quickly followed Acheson's invention of electric furnace or synthetic graphite. The patent files are filled with inventions applying the materials to one purpose or another, but little came from most of them.

With the recession following the war the carbon and graphite manufacturers naturally investigated those places where sales could be expanded to take up their greatly increased plant facilities made necessary by World War I.

One of the developments of that period was carbon brick which first found use in lining digesters for the production of sulphite paper. From that it was a short step to lining pickling tanks as shown in Figure 6, where carbon found acceptance because of its resistance to attack by the corrosive solutions. In 1926, Acme Steel Company in Chicago first put in carbon brick for handling dilute H_2SO_4, and the Leechburg Steel Company in 1930 was the first to use carbon for the more corrosive solution required for pickling stainless steel. Some of the earliest lined tanks are still in service, well proving the value of carbon in that application. Today carbon brick are made in a wide variety of sizes including the usual wedges, arches and straights in the $9 \times 4\frac{1}{2} \times 2\frac{1}{2}$ in. standards which are widely used in both the iron and steel and chemical industries. Carbon brick may be laid up with most of the chemical cements as well as the carbon cements. Practically all stainless steel

pickling is done in carbon lined tanks because of the corrosive nature of the pickling solution.

Another development of about the same period was carbon Raschig rings, small, hollow cylinders of carbon now widely used in the chemical industry. The first steel plant use was by American Steel & Wire Company in scrubbing towers for removing CO_2 in connection with a bright annealing process. The carbon Raschig rings have all the good qualities of carbon in so far as resistance to chemical attack is concerned and are particularly useful in caustic solutions. The rings are much lighter than metal and ceramic rings which may be an important consideration when designing equipment.

An application of carbon which had its beginning in 1928, was the use of carbon tubes in a Cottrell precipitator for the recovery of phosphoric acid. The experimental work employed tubes made by boring holes through 12 in. diameter electrodes. The operation was so successful that the tubes were produced in quantities to permit equipping an entire tower which soon led to building the tower itself of 8 × 8 × 120 in. carbon blocks laid up with carbonaceous cement in log cabin fashion in place of a tower built of chemical brick. The first tubes were still in service in 1942 when the equipment was shut down because of a change in operations. This use of a large carbon structure encouraged the Carbide and Carbon Chemicals Corporation at South Charleston, West Virginia, which had been using carbon tubes in a Cottrell precipitator for the recovery of sulphuric acid, to install a carbon tower. These carbon tubes had outlasted two chemical brick towers and were still in such good condition that they were reinstalled in the carbon tower when it was built, and are still in service.

The carbon tower was built of slabs 11½ × 28½ in. × up to 15 ft long, so laid up with cement that special corner blocks held the wall blocks together. The tower was 15 ft square, 27 ft high, surmounted by a stack 17 ft high made of carbon tower sections 38 in. outside diam × 33 in. inside diam × 36 in. long. Construction of the structure took ten days compared with 5 to 7 weeks needed for chemical brick.

A unique part of the construction was the use of carbon beams 4 in. wide by 28½ in. deep and 13 ft long for supporting the 81 carbon tubes installed. The beams replaced single brick wide arches which were very difficult and time-consuming to install and expensive to maintain. The first tower has been in daily use for more than 5 years with no sign of deterioration.

World War II brought about tremendously increased need for sulphuric acid in the manufacture of explosives with the result that increased quantities of carbon tubes, beams and blocks were purchased for construction of a great many Cottrell precipitators used in acid recovery units in connection with explosives plants.

It is impossible to cover all the many minor uses of carbon as they developed, but by 1930 the unusual qualities of carbon and graphite were being appreciated and since then these materials have come into their own. It is probable that the development of a truly impervious carbon and graphite was the spark that started the wide expansion. Those familiar with carbon realized if it could be made impervious (both carbon and graphite are porous to the extent of 20-30 per cent)

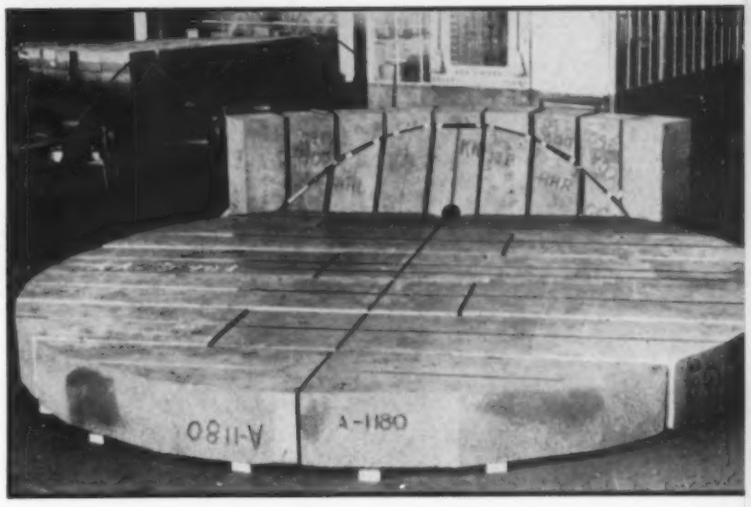


Figure 4 — Carbon hearth blocks for a ferro-alloy furnace lining.

▲

Figure 5 — Carbon lined ferro-alloy furnace in operation.

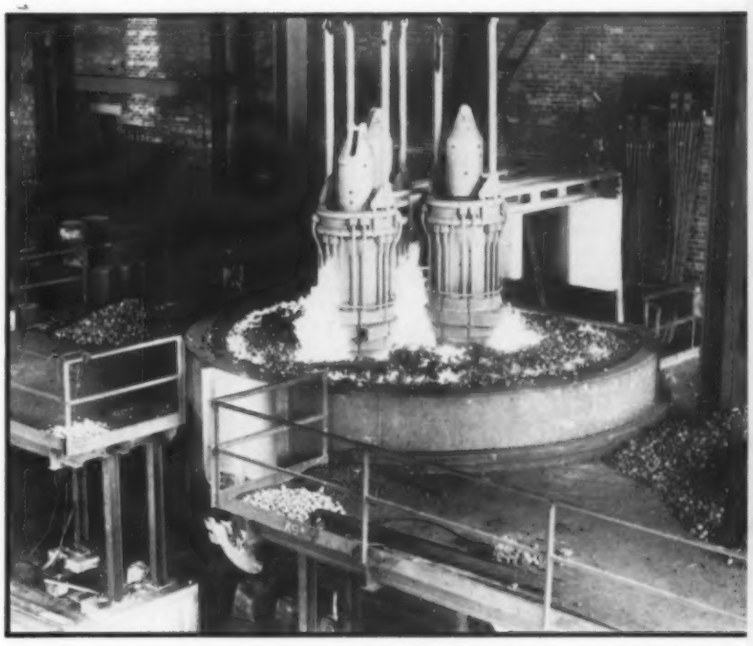


Figure 6 — Carbon brick lining for a pickling tank.

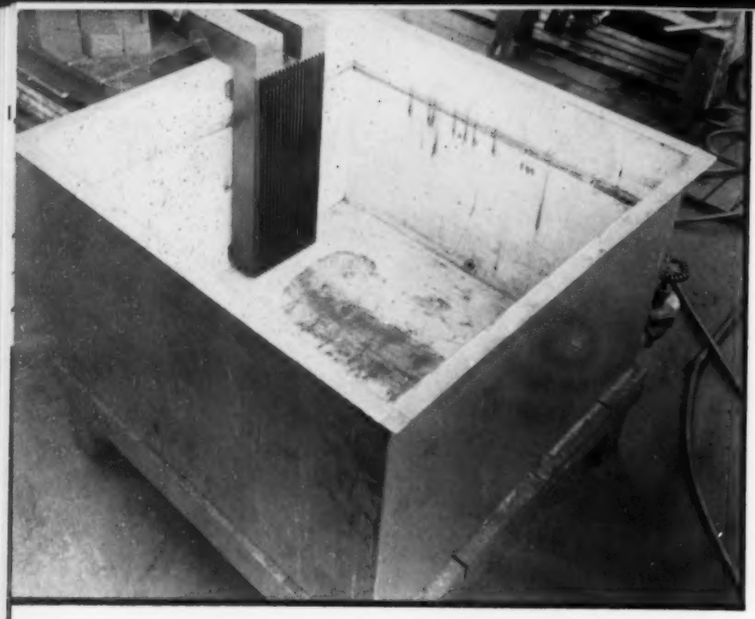


Figure 7 — Plate heater made of impervious graphite hung on edge of tank.

such a product would find wide use provided the impervious material lost none of its inherent properties.

The first application of the new products, now well-known as "Karbate" materials, a trademark for impervious carbon and graphite, was in heat exchangers where it was possible to take advantage of one of the outstanding characteristics of graphite, namely, high heat transfer. Probably no characteristic of graphite has caused as much comment as its ability to transmit heat, in extent about equal to brass and aluminum, three times that of carbon steel, five times that of 18 and 8 steel and 100 times that of glass and ceramic materials. Where resistance to corrosion, combined with the transfer of heat was a problem, impervious graphite filled a long felt want.

HEAT CONDUCTIVITY OF VARIOUS MATERIALS

Material	Btu/sq ft/°F/hr/ft		
Copper	224	*	32 F
Aluminum	75-131	**	(Room temp)
Brass (red)	93	**	(Room temp)
Karbate No. 21, 22 and 28 (graphite base)	75		200 F
Admiralty	65	**	(Room temp)
Tantalum	32	**	(Room temp)
Hi silicon cast iron	31	**	(Room temp)
Steel, 1 per cent carbon	26	***	64 F
Chemical lead	20	**	32-212 F
Antimony lead	17-20	**	32-212 F
18-8	7.3-17.0	**	32-212 F
Nickel chromium (17 per cent nickel, 13 per cent chromium)	8.5	**	(Room temp)
Karbate No. 11, 12 and 18 (Carbon base)	3		100 F
Boro silicate glass	0.63	***	86-167 F
Chemical stoneware	0.83	**	
Fireclay brick	0.6-0.74	***	932 F

* International Critical Tables.
** Chemical and Metallurgical Engineering, November 1938 pages 633-659.
***"Heat Transmission" — (McAdams, 1933) page 314.

The iron and steel industries, many in the chemical field and the plating field, are using constantly increasing numbers of heat exchangers of several types built around impervious carbon and graphite materials. The first use of tube bundles of this material was in the electrolytic tin plating line of the Carnegie-Illinois Steel Corporation at Gary, and the exchangers are still in service after nearly 8 years.

Many of the first exchangers were of the coil or concentric tube types. These did their work, but in the rough handling that seems to be a part of making steel, the tubes were occasionally broken. A different and stronger type of heater was needed, and it has been developed and is increasing the field of application of the material. This type of equipment, called plate heaters, may be used for either heating or cooling. A plate heater consists of one or more slabs of graphite 4 × 10 x 48 in. drilled lengthwise and crosswise to provide the channels through which the heating medium, steam or hot liquid, or cooling medium may flow. The faces of the plates are grooved to provide additional surface, and several plates may be cemented together to increase the capacity. The plate heaters may be hung from the edge of a tank as shown in Figure 7 or supported from the bottom and generally placed so as to be out of the way of material entering or leaving the tank. Scale or sludge if it forms on the plates can be easily removed.

Impervious carbon and graphite materials resist all but the most highly oxidizing chemicals and are particularly useful in handling phosphoric, hydrochloric, hydrofluoric, and sulphuric acids and mixtures of nitric and hydrofluoric acid. The material resists hydrochloric acid at all concentrations and at temperatures up to boiling, which has made it useful in the manufacture of the acid as well as in acid application fields.

While it was an achievement to produce the impervious material as pipes, blocks, etc., it was necessary to go much further if industry were to be satisfied. Fittings, elbows, tees and couplings were needed, then valves and pumps and many complicated forms of equipment, such as condensers, cooler-absorbers, etc. One by one those were made available to the various industries.

Valves were first made in diaphragm type, which was a rather simple adaptation of the impervious material to a new use. Eventually a "Y" type valve was made, but that type is heavy and awkward to use. Now a standard globe valve is available in the one and two-inch sizes that is giving excellent service.

The pumps are so made that the corrosive chemical comes in contact only with the carbon and graphite parts, and such pumps have been in service several years in a number of plants handling most corrosive chemicals. A large number are handling hydrochloric acid and hydrofluoric acid. The pumps range in size from 50 gallons per minute against a 50 ft head to 480 gallons per minute against a 70 ft head. Figure 8 shows one model pump.

In the beginning of the application of impervious carbon and graphite materials in the various fields, pipes were joined together or joined to other equipment by threaded, flanged, and cemented means. The physical properties put these materials in the structural materials class along with ceramics and glass. Accordingly, a line of special fittings has been designed so that tubes can be joined together or attached to other equipment with entire satisfaction.

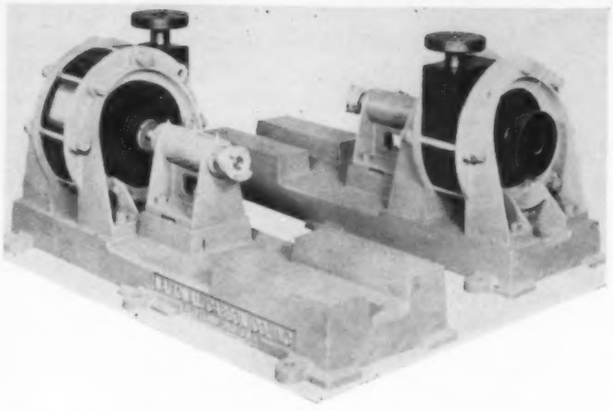


Figure 8 — In this pump the corrosive chemicals come in contact only with impervious carbon and graphite parts.

for stools, both as circular and rectangular inserts set into or cast in the iron stools, or as the complete stool. Both carbon and graphite have been tried for this purpose and results indicate that graphite is the more economical material.

At about the time the impervious carbon and graphite materials were developed, experimental work was started on the use of carbon mold plugs, Figure 9, in place of ceramic. The application was so successful that the plugs were then made in quantity for this service. The carbon material was more expensive than clay, but the cost per plug has been reduced by volume production to a point where, considering the advantages of the carbon material, it is economical. With proper handling, carbon plugs may be used several times. Hot metal does not stick to carbon, the use of carbon eliminates the danger of inclusions, while there is absolutely no evidence of carbon pickup even with low carbon heats. The use is expanding and has become standard practice in many mills.

A number of mold plug designs have been tried out, but the most popular size is now approximately 6 in. largest diameter and 3-5 in. thick. A design called the mushroom plug, in which the top is flared out to cover more of the bottom of the mold, was investigated; but results did not appear to warrant the costs. It is probable that a size slightly larger than 6 in. will be the final design, so that, with reasonable care, the stream of metal will always impinge on the carbon. Such a plug should be satisfactory and economical.

A natural development growing out of the carbon mold plug application was the adoption of the material

Bethlehem Steel Company at Bethlehem, Pennsylvania, was the first to make a thorough trial of carbon and graphite stools. A tapered disc 20 in. in diameter was used, set into the underside of the stool and held in position by a steel plate under it. Iron inserts had to be replaced after each pour, a hot, disagreeable job on which it was difficult to keep men. The graphite insert lasted throughout a week's cycle, a marked difference and one greatly appreciated, even in cold weather.

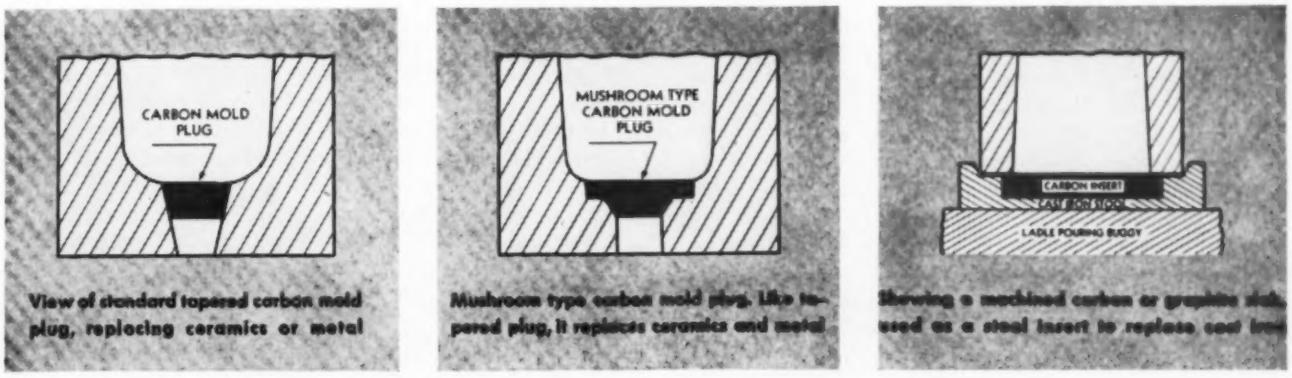
In May of this year, Messrs. Black and Connelly of Jones & Laughlin Steel Corporation reported to the Pittsburgh meeting of the A. I. M. E. on a series of experiments extending over a period of several months on carbon and graphite stools. In these experiments, their stool was cast around either a slab of graphite or carbon 16 × 30 × 5 in. thick. The stool proper was 47½ × 72¼ in. in area and was used for 27 × 52 in. big-end-down ingots.

Several interesting facts were brought out in their report. First, it was found possible to cast the metal of the stool proper around either the carbon or graphite slab without crushing the insert when the iron contracted in cooling. This is, of course, an inexpensive way of preparing the stool and makes certain that the carbon material is held firmly in place. Second, it was found that while using the stools with inserts in pouring 1200 ingots (later reports indicate 1500 ingots) not a single sticker resulted. This is a matter of considerable importance but one difficult of translation into dollars and cents value.

At the time of the report, with the experimental work incomplete, the authors state that the results obtained from one grade of graphite were such that the extra cost of the inserts was nearly offset by the increased number of pours they secured from the special stools. In actual figures, they secured 57.7 per cent increase in ingots poured per stool, while to trade dollars they should get 83 per cent increase. This comparison entirely disregards the value of having no stickers.

The authors state further that they believe the cost of their cast iron stools is unusually low as it represented not much more than the cost of converting blast furnace iron into stools in their own foundry, and that in cir-

Figure 9 — Sketch of two types of carbon mold plugs, as well as a carbon insert.


CARBON MOLD PLUG
View of standard tapered carbon mold plug, replacing ceramics or metal
MUSHROOM TYPE CARBON MOLD PLUG
Mushroom type carbon mold plug. Like tapered plug, it replaces ceramics and metal
CARBON INSERT
LADLE POURING BUGGY

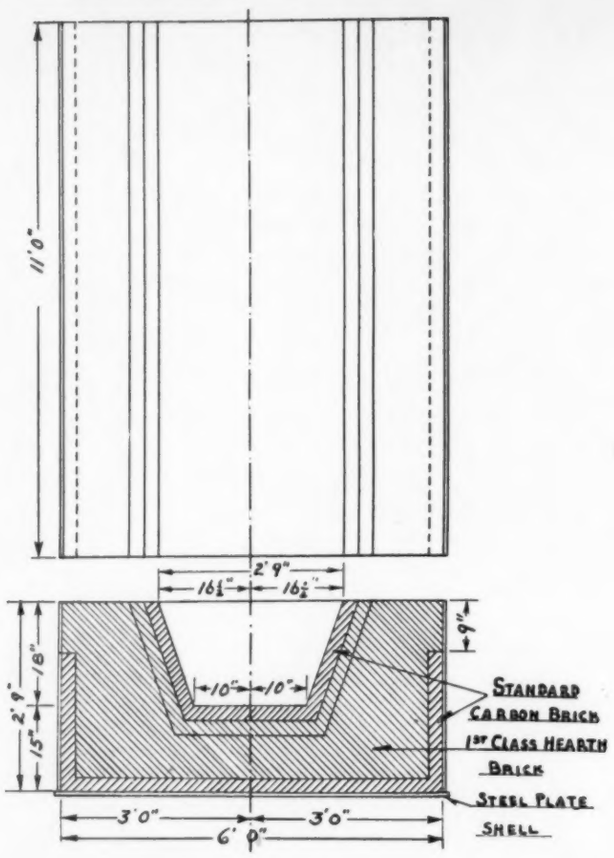


Figure 10 — Carbon brick lining of blast furnace run-out trough.

cumstances where stools have to be purchased, as is usually the case, the dollar relation would appear in favor of the graphite. They state also that the comparison is made on the basis of the actual cost of the graphite slabs which it is believed could be reduced by large quantity purchases. A point that was not mentioned is that the experiment did not prove the stool need be as large as 16 × 30 in. A slightly smaller stool costing a little less might function just as well thus wiping out the small differential existing.

Messrs. Black's and Connelly's report stirred up a great amount of interest among both stool users and stool makers and much experimental work is being carried on as a result. It is sincerely hoped that when Messrs. Black and Connelly complete their tests, they will make a complete report for the benefit of the entire industry.

Along entirely different lines and of interest to another part of the industry was the experimental work carried out at Lebanon Steel Foundry, Lebanon, Pennsylvania, under the direction of H. C. Phillips, plant manager. Mr. Phillips believed that by properly placing a carbon rod in a blind riser, the riser could be made to function to better advantage. The experiments, in which my company cooperated, were carried out over a very considerable period and did prove Mr. Phillips' position. It was proved that when a small diameter graphite rod, for example a quarter inch rod in a 3-5 inch diameter riser, was placed crosswise of a blind or semi-blind riser and about one-third of the way from its top, the size of the riser could be materially reduced either in cross section or height, or both, thus decreasing the percentage of metal in the riser. In spite of the reduction in riser size, the resultant castings were more perfect than when other methods were used because the shrink cavity was short and flat bottomed rather than carrot shaped and did not tend to enter the casting proper.

It was found that the carbon content in the riser increased adjacent to the rod, but that it could be controlled by correct selection of rod size and position. The rod was consumed which added heat to the riser metal thus making it more fluid, while the increase in carbon content increased fluidity also. Both conditions assisted in producing sounder castings even though the amount of poured metal was reduced.

Farrell Cheek Steel Company, Sandusky, Ohio, experimented with the described method of open risers with similar satisfactory results. That industry would have to change its very nature if one could report universal acceptance of the idea. Some foundrymen had most satisfactory results and continue to use the method, or one of several modifications, while others were dissatisfied with the outcome and dropped the suggestion. Properly applied and used, the graphite rod can and does serve a very useful purpose.

The use of graphite for molds in both ferrous and non-ferrous casting of metal has been of interest to many operators. Several characteristics of graphite make it particularly useful in the field. Metals and slags do not wet it, nor do they stick to it. It is highly resistant to heat shock, so much so that white hot graphite can be dropped in ice water without fear of damage. Graphite has high heat capacity as well as high thermal conductivity. It may be easily machined on woodworking equipment with resulting fine surfaces. By proper design, the temperature of the mold can be kept below the temperature at which oxidation takes place. These inherent characteristics are particularly valuable in connection with graphite molds for centrifugal casting of both ferrous and non-ferrous metals, a field of application which is growing rapidly.

Brush Beryllium Corporation, Lorain, Ohio, was one of the first serious investigators of graphite as a mold material. Results were so satisfactory that practically all their beryllium copper is now cast in graphite molds. Another concern which has used it with success in a small way is International Nickel Company at Huntington, West Virginia. A number of concerns are experimenting with graphite molds for small ingots.

A new application of graphite is as molds for overmetal, both ferrous and non-ferrous, in place of iron or sand molds. In this case a number of molds are set up in frames or racks so that the molds can be quickly dumped for repouring. The high heat capacity of the mold quickly chills the pig and since the metal does not stick to the mold it drops free upon reversal of the mold. With reasonable care the graphite molds should last ndefinitely with a lower cost for the handling of overmetal than when the other types of molds are used.

Still another comparatively new use of carbon on which there has been considerable experimental work, in this country at Carnegie-Illinois Steel Corporation in Pittsburgh and at the Appleby-Frodingham Works of the United Steel Companies, Ltd. in England, is the lining of run-out troughs and even runners of blast furnaces, Figure 10. The metal and slag do not stick to the carbon brick. Oxidation after a tap can be pre-

vented by brushing the bricks with a clay wash as soon as the metal ceases to flow. G. D. Elliot says, "Iron draining from a carbon runner is exactly like mercury draining from a sloping desk. If the iron is cold and of high sulphur content, a skull does form in the runner, but it is always loose." Mr. Elliot says further, "What has been said with regard to iron runners applies equally well to slag runners." It would seem highly probable that the use of carbon to reduce the disagreeable maintenance of these parts of the blast furnace should find general acceptance.

There have been many other uses of carbon and graphite developed during the past ten years or so that are interesting but which have had less general application than most of those described.

Inland Steel, Chicago, some six years ago successfully applied unusually large graphite anodes to an alternating current continuous pickling apparatus. Another use for graphite was as hold-down rolls in still another type of machine as carried out by Brainard Steel Company, Warren, Ohio, and since used by others in similar ways. Carbon has been applied as wiper bars in the tinning process.

Graphite powders are frequently used to prevent oxidation in lead and salt tempering baths and as hot topping compound in ingot hot tops. They have proved useful too as carbon raisers added to the metal in the ladle and when used as part of a high steel scrap charge in the open hearth, when the use of scrap is desirable in place of pig iron. They have been successfully briquetted with iron borings for part of the cupola charge. Electric steel furnace operators for many years have known and used carburite, a mixture of carbon, iron, fluxing and bonding materials, as a carbon raiser for their charges and many also have used sized electrode scrap for the same purpose. Carburite was one of the first, if not the first, specialty product. Many operators are familiar with graphite grease mixtures used in various parts of the steel mill where high temperatures exist and where low friction must be maintained, as for example, in roll neck bearings.

This paper is an attempt to present a comprehensive idea of many of the ways in which carbon and graphite are used in your industry. It is not 100 per cent complete but is at least indicative of the acceptance of the carbon materials. Considering the conditions under which much of the development of these specialty products has taken place, it is easy to prophesy that when the iron and steel industry has the time to really do experimental work, the fields of carbon and graphite will be greatly expanded.

DISCUSSION

PRESENTED BY

E. A. HAWK, Fuel Engineer, Tennessee Coal, Iron and Railroad Company, Ensley, Alabama

V. J. NOLAN, Assistant General Sales Manager, National Carbon Company, Inc., New York, New York

W. R. POTTS, Assistant Chief Engineer, Mechanical and Electrical Construction, Atlantic Steel Company, Atlanta, Georgia

PAUL J. BOWRON, Superintendent, Annealing Department, Tennessee Coal, Iron and Railroad Company, Fairfield, Alabama

R. R. THOMAS, Assistant Chief Engineer, Tennessee Coal, Iron and Railroad Company, Ensley, Alabama.

FRANK VOSBURGH, National Carbon Company, Inc., New York, New York

E. A. Hawk: I would like to ask Mr. Nolan whether or not these large bottom blocks in the blast furnaces are interlocked in any way.

V. J. Nolan: The horizontal hearth blocks are laid in two layers, each block used is 22½ in. thick and 30 in. wide. The blocks are joined by tamping carbon paste into the joints which bake out with the heat of the furnace into solid carbon, producing virtually a monolithic structure.

W. R. Potts: I would like to ask if you have done work on dry skids for reheating furnaces such as made by the Carborundum Company.

V. J. Nolan: The only application we have that is in permanent use and that might be compared to that, is the use of graphite slabs on the far side of an extrusion table where aluminum utensils and other special shapes are being manufactured. The utensil is released and slides onto a graphite slab covered table.

Paul J. Bowron: Might I ask, is it necessary that the application be in a reducing atmosphere?

V. J. Nolan: No, because in such an application, graphite, because of its high rate of heat transfer, will dissipate heat very rapidly and you never heat your graphite up to a temperature where oxidation takes place. To be troubled with graphite oxidizing, you would have to maintain your temperature in excess of 550 C, and beyond this temperature, a furnace should be reducing.

R. R. Thomas: Has insulation between the carbon blocks and the hearth jacket been considered to reduce the heat loss, especially where water-cooled hearth jackets are used?

Frank Vosburgh: Because carbon has a higher heat transfer rate than ceramics, that question has come up. However, the thermal conductivity of graphite is peculiar; the hotter your carbon or graphite gets, the lower its thermal conductivity. Carbon starts out at about 3 Btu and can be carried up to extremely high temperatures, but at 3000 F, its thermal conductivity would be about 1½ Btu. On the other hand, ceramic material starts out very much lower, around 0.4 Btu and the conductivity of that material, if you could carry it to a 3,000 F temperature, would be in the neighborhood of one Btu. Of course, fire clay brick will not stand that temperature, and breaks down at around 2,700 F. In some computations we have made, the heat lost through an all-carbon lining at 2,800 F was about

(*Please turn to page 78*)

Aid TO CONTROL OF *Open Hearth Practice* BY STATISTICAL METHODS

. . . . quality and economy control are everlasting goals in steel production . . . . statistics are an invaluable aid in attaining these goals . . . .

by R. E. Dienst

PRODUCTION AND COST ANALYST

GREAT LAKES STEEL CORPORATION

ECORSE, DETROIT, MICHIGAN

▲ IN open hearth steel-making, with all of its various products which must be made to standard and customer specifications, and with its various types of charge, types of furnaces, kinds of fuel and its many other operating variables, a large demand is created for analyses, reports and data covering all its multiple phases of practice. Besides the necessary metallurgical information which is of prime importance, tabulations and data must be kept on operating practice, furnace and roof life, fuel practice, personnel performance, charge materials used with respect to both quantity and quality, schedules on repair programs, construction data, equipment records including moulds and mould life and many others. Detail on much of this must be assembled daily, weekly, monthly and even annually to keep directional trends in view at all times and to insure economical operation, quality products, and a maximum output of tonnage.

In view of these things which are so vital to a successful operating department, the data and records take on an aspect of importance and much careful preparation must be done to obtain constructive use of them. To be of sound value, these data must be prepared not only accurately and properly but presented uniquely and exactly so the results can be seen readily, and amplifying the subject in a way to attract attention. Charts or graphic illustrations provide ideal means for presentation, inasmuch as they readily show trends, command attention, and point to the obvious conclusions more directly than lengthy tabulations or reports. While most successful supervisors find it necessary to spend most of their time on the job, it is possible, if supplied with proper reports or charts, for them to direct the activity of the organization by the use of them without personal contact at the scene of operations. Daily or weekly charts showing trends of operation are valuable guides for detecting changes in practice soon enough to prevent loss of time, effort, or valuable materials. With these objectives in mind, the production clerk, practice foreman or analyst must lay out a plan of activity that will provide useful information which can be put to practical use. There are always weaknesses that develop in daily operations which can be given a lift and put on a sound basis by the aid of good reports.

Presented before A. I. S. E. Detroit District Section Meeting, November 20, 1945

CHARGING PRACTICE

Open hearth charging practice can very often be materially delayed for different reasons causing longer heat time and loss of production. It is not always an easy matter to apprehend causes for delay so that corrective action can be taken. A daily record chart showing average scrap weight per buggy or buggies per heat plotted against average heat time or tons per hour can be useful in controlling stockhouse loading activity and help explain variations in daily operating rates. If there have been no reported delays caused by transportation of materials to the open hearth floor, the only other chief causes for delay to charging would be light or bulky scrap or poor loading practice.

Following the dotted lines shown on Figure 1, there can readily be seen a striking relationship between weight per buggy and tons per hour. More weight per buggy means fewer buggies per heat and less charging time. At times when only light scrap is available, charging operations can be seen to slow up substantially because of this handicap.

Hourly charging schedules can be of valuable assistance to melters, mixermen or hot metal dispatchers in keeping in close touch with charging activity on a large group of furnaces. A report of this kind can assist in avoiding bunched heats by coordinating hot metal deliveries to furnaces. Delays can thus be avoided, and operating personnel will find it helpful at the change of turns. This report can be a simple form with furnaces recorded across the top and hourly time intervals down the left side. As each furnace charges, the time can be recorded under the furnace at the designated hour. Approximate time for metal can thus be anticipated, and when heats become bunched, confusion and lost time can at least be partly avoided.

PRODUCTION DATA

Operating trends in daily furnace production are vital to open hearth supervision. When many furnaces are in operation it is difficult to watch productive results accurately on many furnaces without the aid of some report, chart or medium that points out the daily trend of production on each furnace, or group of furnaces. Production rates may vary considerably from day to day so that true operating trends cannot be seen from daily records. At times productive rates will be allowed to fall off unnoticed for a period of time, and much tonnage can be lost before the cause is apprehended. Cumulative monthly records or progressive averages are valuable guides to point out readily the trend of operation, so that a downward thrust in operating rates can be seen and arrested before too much time has elapsed. A report of this kind displayed in a prominent place upon the open hearth floor where furnace operators can watch their own records has been found to add impetus to production rates and create rivalry among furnacemen. These posted operating rates can then be evaluated quite accurately by making due allowances for types of steel being made, remaining roof life or other good reasons which cause variation in operating rates of production.

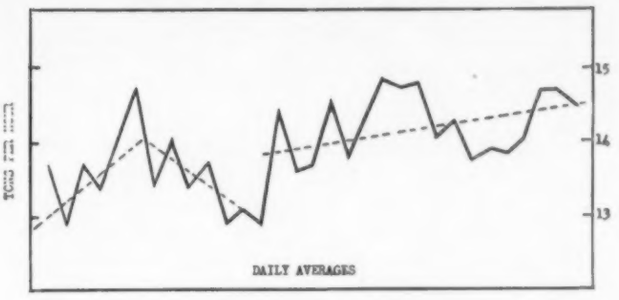
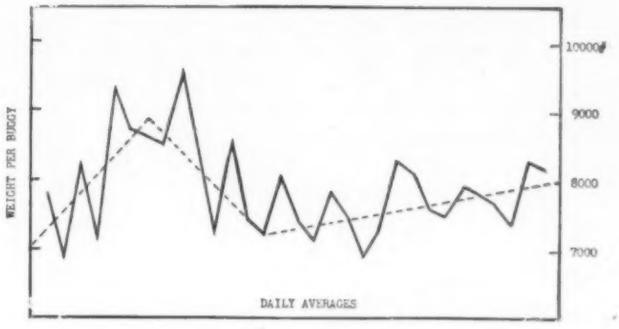


Figure 1 — A comparison of the two curves shows how the tons per hour (upper curve) varies with the weight per buggy (lower curve).



CHARGED WEIGHTS AND INGOT YIELDS

Charged weights and ingot yields are of vital importance in open hearth practice, both from the standpoint of maximum output per hour and minimum cost per ton. Faulty loading and weighing practice can produce substantial variations from furnace to furnace, or from heat to heat, and result in low ingot yields. Careful check on tare weights of charging buggies, periodic inspection of scales, and careful scheduling of charge materials to make definite size heats must be constantly watched if economy in furnace practice is to be achieved. Even with careful attention focused upon these important details, and in spite of well outlined procedure, much good tonnage can get away because of other reasons.

Repairs to charging buggies, variations in charging box weights, scrap falling between boxes which does not get charged, "guess weights" and "average tares" create a constant source of trouble in accounting for charge materials, and help defeat good charging practice. It is for some of the reasons outlined that weight discrepancies occur, and the need for diligent effort to overcome them is constantly necessary. Relief from some of these troublesome problems in weighing have been overcome in recent years by the installation of automatic weighing scales. Procedure in weighing on these newer scales has been speeded up so that "guess weight" and human errors are practically eliminated. "Average" tares can be assumed and net weights automatically recorded, or individual tare weights for each buggy deducted from gross weights, whichever is the most desirable. This contribution has helped to over-

come many of the difficulties caused by faulty weighing, which resulted in erroneous charged weights, and ingot yields.

There is a human inclination for furnacemen, ambitious to make tonnage to get the maximum amount of charge materials into their heats, the objective being a larger heat for more ingot tonnage. There are many times when this works exactly as planned, but as often fails. If a large ore or pig addition or hot metal "drink" is needed to work the heat, the result is excessive charged weight for the ladle. The result in tapping is excess pit scrap and low ingot yield. A vivid example of how this works can be seen on Figure 2.

Per cent of ingot yield has been plotted against increase in metallic charged weight on a substantial number of heats to determine how yields were affected. The chart reveals maximum yield on 225 ton heats with approximately 520,000 pound of charge. From this point on, yield begins to decline with more charge weight until lines intersect at 230 tons. Maximum charge at this point is seen to be about 535,000 pounds per heat and yield 86 per cent. The obvious conclusion to be drawn is that for economy in practice, the largest heat to be obtained with the maximum yield confines the practice to a range of 520,000 to 535,000 lb charge and a heat size of 225 to 230 tons. Above this point ingot tonnage is made at the expense of loss in yield. Data for these determinations were taken from flush heat practice.

FUEL PRACTICE

Fuel consumption is one of the elements of practice which is of vital concern to open hearth operating men. The consumption of this valuable commodity commands as much attention by supervision as operating rates, and, because of their close relationship, are usually associated together. As in the case of operating rates, fuel consumption can be watched in much the same manner. Cumulative daily records or progressive averages by furnace are valuable to follow and point out the trend of fuel consumption in a manner sufficient to apprehend good or poor practice, so that in the case of the latter, reasons for poor practice can be readily seen and corrective measures taken in due time to prevent needless waste. Joint records or charts on productive and fuel rates can be made associating both together for any given period of time, and by including other relative data such as percentage of alloy tonnage and remaining roof life, enough information is consolidated to provide a suitable analysis for measuring the efficiency at which each furnace is operating. An example of such a summary is shown in Figure 3.

Many times it may be found necessary to go beyond the outline described above and make further determinations to seek reasons for poor fuel practice on certain furnaces. Where a shop is using combination fuels such as mixed blast furnace and coke oven gas alternating with fuel oil, a common denominator of equivalent gallons of oil per hour or some other suitable unit of measure can be set up to follow fuel practice by turns. This of course requires meter readings at the end of each turn to furnish data for calculation, but this application has revealed amazing differences in fuel practice among operators, some of which could not have been determined without this further detail. It is necessary in doing this to select and use a sufficiently large time interval so that results shown will be equitable. If a period of a month is summarized following operators as they change shifts, sufficient time will have been allowed for each operator to work all the various stages of heats, the results will be fair to operators, and the summary will give a reasonably true picture of how the fuel was used. If these tabulations reveal the same trend in operators in successive months, it can then be assumed to be timely to help or correct the ones who are out of line. An example of a summary of this kind is shown on Figure 4.

Figure 2 — The solid curve shows that the per cent yield of a heat increases up to a certain point, but beyond this point, the weight per heat (dotted curve) is increased at the expense of the yield.

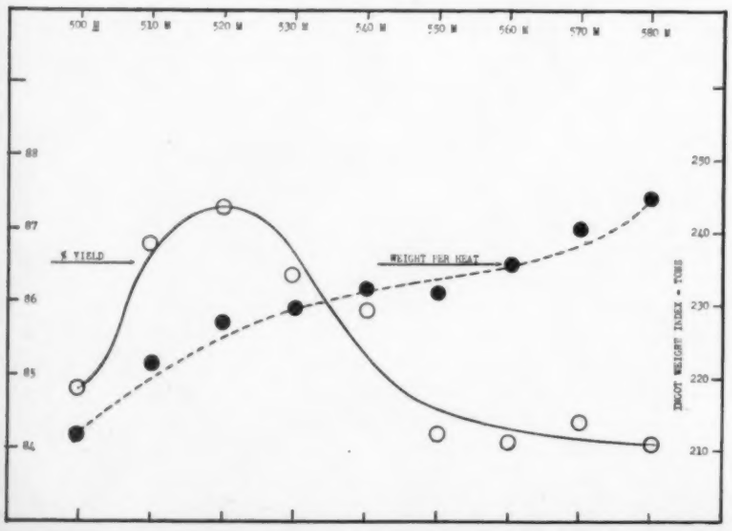
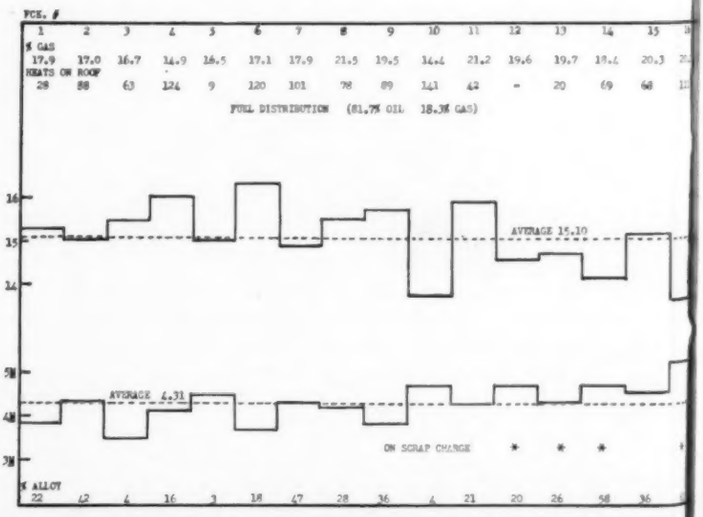


Figure 3 — The production rate of a series of furnaces is compared on this chart with the fuel rate. Data is also given on the fuel ratio, roof life and product of each furnace.



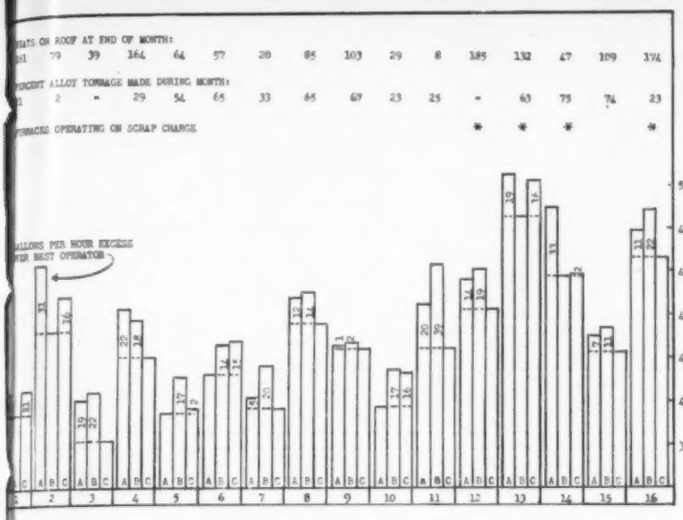


Figure 4 — The chart compares the fuel consumption by turn for the three operators of each furnace.

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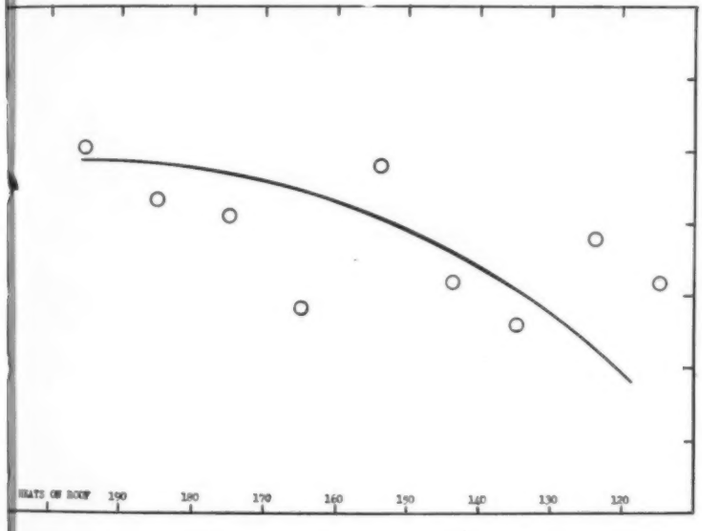
Figure 5 — The chart shows that roof life is decreased as the percentage of alloy tonnage is increased.



By examination of the data on this chart it may be seen that the chief objective is to compare the results of one operator with another on the same furnace, and not necessarily to compare turn results on various furnaces, unless allowances are made for the different operating conditions which exist between furnaces. Inasmuch as all turns on any one furnace should average alike on the same heats, the only differences that exist are the various stages of charging, melting, refining and tapping. These along with bottom repairs will average out in a month's time so that there should be little or no difference between operator performance in that time. The results that can be accomplished from this detail are easily worth while, for when the facts are obvious, no furnace operator will want to have the poorest record on fuel. An evaluation of these differences in practice between operators shown as "excess gallons per hour" can amount to a significant sum in a short period of time. If half the differences found can later be saved, the effort will have been well worth while.

ROOF LIFE

Roof life on open hearth furnaces can show as much variance as most other things about open hearth practice. In making an evaluation of the causes for good or poor roof life, many things must be considered. Design and construction including kind and quality of brick may be assumed to be of first importance. Improper burners, or burner alignment can ruin the best roof ever put on a furnace in comparatively a short period of time. The kind of fuel used may be assumed to be an attribute, and among other things, type of charge materials must be considered as a prime factor in the ultimate life of a furnace roof. Type of steel produced also has an important bearing upon roof life and may be illustrated by the following chart.

Figure 5 deals with decrease in roof life as plotted against increasing percentages of alloy tonnage, the latter meaning all hot-topped grades excepting forging and deep drawing quality. It can be readily seen that there is pronounced decline in roof life with the increase in alloy tonnage. This is at least partly explained by the longer heat time required on these grades because of alloying additions and composition of charge. Because of the large alloying additions to be made, heat temperatures must be higher, thereby extending fuel requirements. These conditions are contributing factors to deficiency in furnace roof life, although most open hearth people are familiar with many other things that make adverse contributions.

SCRAP SEGREGATION

Segregation of domestic and other scraps has been practiced throughout the steel industry for some time and the reasons for its importance became very obvious during the past war. Certain alloy materials became scarce and critical enough to warrant some tonnage allocations to the electric furnaces where maximum recovery was possible. The economic value of segregation to the open hearth may be well illustrated in the tabulation of Table I.

Segregation can be seen to have at least two important functions, pounds per ton used and cost per ton saved. Much future recovery of these important materials is possible when the vast tonnages of the alloy

TABLE I

Alloy	Possible recovery	Will save in fce. addition	Residual points in bath		
			.05	.10	.20
Molybdenum	100%	Pounds per ton Cost per ton	1.13 $0.90	2.26 $1.81	4.52 $3.61
Chromium	30%	Pounds per ton Cost per ton	2.10 $0.18	4.22 $0.37	8.43 $0.73
Manganese	20%	Pounds per ton Cost per ton	2.35 $0.15	4.71 $0.30	9.42 $0.60
Nickel	100%	Pounds per ton Cost per ton	1.13 $0.40	2.26 $0.79	4.52 $1.58
Copper	100%	Pounds per ton Cost per ton	1.13 $0.11	2.26 $0.22	4.52 $0.43

steels made during the war find their way back to the open hearth, and it is evident that the economics of segregation will continue to be of prime importance in future years because of the increased demand for alloy steels being used in industry.

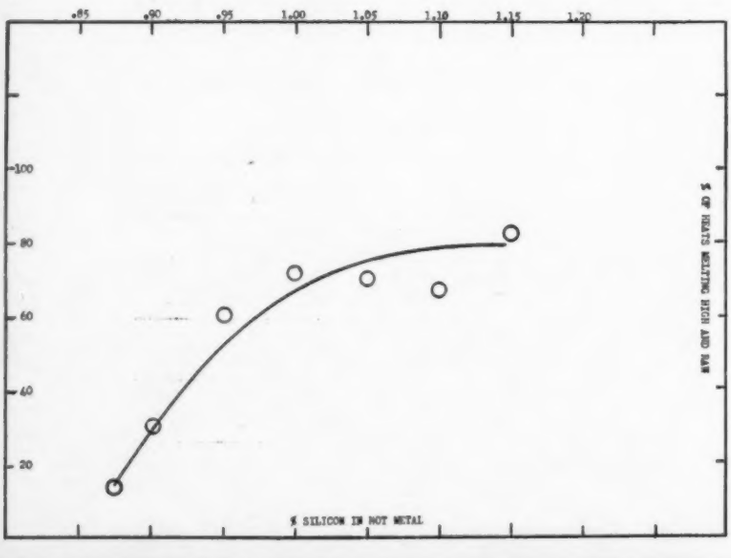
THE EFFECT OF SILICON IN HOT METAL UPON OPEN HEARTH PRACTICE

With the advent during the war of a greater percentage of alloy steel in the total open hearth production, and the evident advantage of such steels, it became necessary for the open hearth to revise some of their former production practice. Remelting scrap inventories were rapidly being depleted and many furnaces went out of production because of this shortage. This brought about a change over in practice to the use of higher percentages of hot metal in the charge. With every change in practice, new problems arise.

The value of controlled silicon and other elements in the hot metal from the blast furnace became more important to the open hearth because of the increased percentage of the hot iron charge. Large variations in silicon analyses from cast to cast were found to create a greater melting problem, particularly on scrap and iron heats. With furnaces charged for average conditions, a cast of metal from the blast furnace unusually high or low in silicon became more of a melting problem than in former practice. In Figure 6, an evaluation of the difficulties encountered can clearly be seen.

The percentage of high melts causing heats to be diverted from one grade to another has been plotted against the range of increase in silicon in blast furnace metal. As the average silicon in the metal increases, there can be seen a corresponding increase in the percentage of high melts. This difficulty later became less acute when flush heats were adopted, the practice on which becomes the next part of this discussion.

Figure 6 — The curve shows that when the silicon is increased, a greater percentage of heats melt high, necessitating diverting the heat to other grades.



FLUSH HEATS

Since open hearth practice in making flush heats varies somewhat from that on scrap charged heats, data for comparison or study must be kept separately. This practice provides ample flexibility in scheduling heats because of the variability of the iron percentages that can be used. Hot metal percentages can vary from 55 to 80 per cent with equal success as regards the quality of the heats. In a shop where all furnaces are equipped for making flush heats, ample flexibility is provided for using a steady flow of hot metal, even though several furnaces may be out of production at the same time for repairs. During a period of this kind, more furnaces can then be assigned to making flush heats, or the iron percentage can be raised upon the ones operating, whichever is most desirable. This practice in conjunction with a hot metal mixer makes an ideal operating plan for a shop some distance away from hot metal supply. The mixer provides facility for prompt delivery of the metal to the many furnaces so that delays are essentially eliminated.

The flexibility of the charge and the variation of the practice employed, however, make operating data more complex to follow and careful analysis is necessary to follow the economic trends of operation. A large group of over 9000 heats representing 2,000,000 tons of ingots has been selected for analysis to obtain a fairly reliable glimpse of operating results. This tonnage made over a period of more than 2½ years employed many changes in practice. At times the percentage of iron was varied both experimentally and because of the availability of hot metal from day to day, or in some instances from hour to hour. Various percentages of charge ore, sinter, or a combination of both were used, as well as cold pig or mould scrap at times necessary to augment the lack of sufficient hot metal. These shifts in practice were of course made due to necessity, or to improve the ultimate quality or tonnage output per hour. However variable the practice, a large group analysis of this kind can be given with a fair degree of accuracy to show definite trends in operation.

Hot metal timing is an essential phase of practice in making flush heats. Aside from the metallurgical function of adding the metal at the right time to obtain the desired flush which is so important in this practice, the records have proved this function to have another practical value which can be seen in Figure 7.

In Figure 7, the time intervals from "start of charge" to time of hot metal addition have been plotted against the total heat time to show the latter greatly extended as more or less the direct attribute of delays getting hot metal charged. Improper coordination of this important function can retard production by as much as 20 per cent. Statistics compiled upon this practice for one entire month show that as metal additions are delayed one hour beyond the normal time interval of approximately 3½ to 4 hours, (depending upon melted scrap) heat times have been extended as much as 3 hours. Late metal delivery will cause a violent furnace reaction, usually accompanied by an excessive flush. More metal is then often necessary to build up the charge to obtain a heat of normal size, and the result is a low ingot yield.

Figure 8 deals with the variation in tons per hour

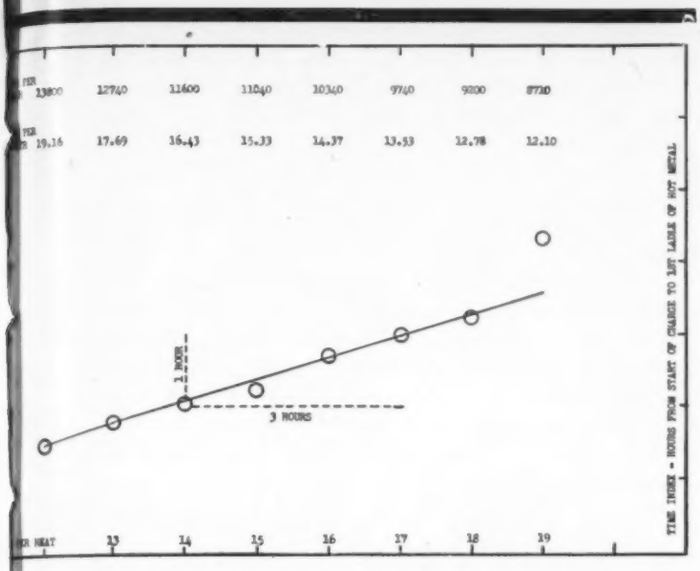


Figure 7 — The graph, which is for sinter heats, shows how delay in adding hot metal extends the heat time about three times the length of the delay.

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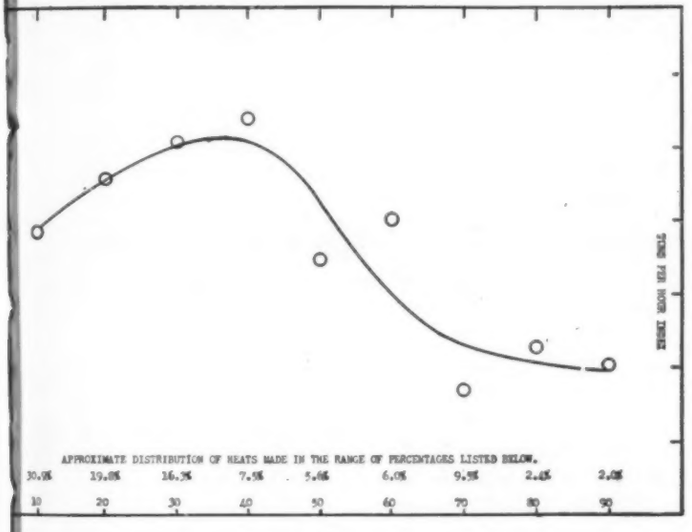
Figure 8 — This chart for sinter heats shows that the yield in tons per hour reduces as the percentage of alloy steels made is increased.


TONS PER HOUR INDEX
APPROXIMATE DISTRIBUTION OF HEATS MADE IN THE RANGE OF PERCENTAGES LISTED BELOW.
30.0% 19.0% 16.3% 7.5% 5.6% 6.0% 9.5% 2.4% 2.0%
10 20 30 40 50 60 70 80 90

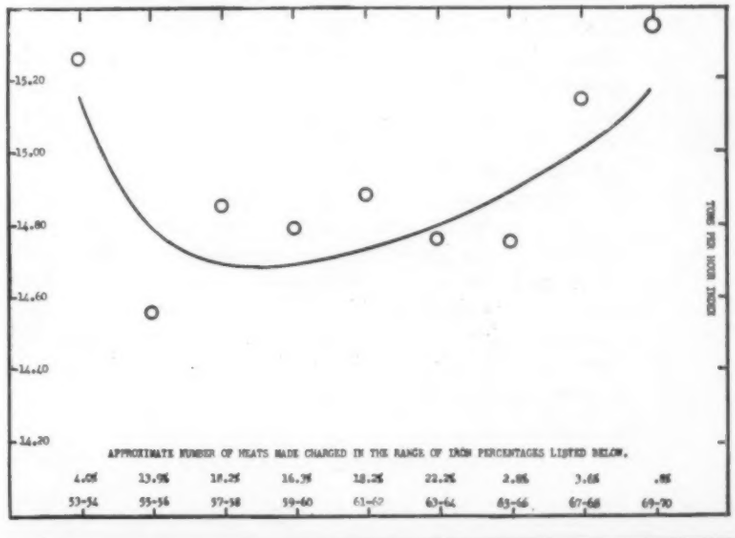
and is plotted against increasing percentages of alloy steels made. Alloy steels referred to consist of all hot-topped grades except forging and deep drawing quality. While it is not uncommon practice to schedule these more difficult heats of steel to the sharper working furnaces to obtain better heat time, no attempt has been made to evaluate the effect of this scheduling practice. Upon examination of the curve on the chart, a reverse or upward trend in tons per hour can be seen in the lower alloy range. This is not normal and can be explained by the effect of the extra heat time penalty imposed upon soft heats which were diverted from alloy. Further increase in alloy tonnage, however, is seen to ultimately reduce tons per hour. Operating rates will be found to retard as much as one-half to one ton per hour in making alloy grades, depending upon furnace condition, charge materials, alloying additions, and other factors contributing adversely. No appreciable loss of time is encountered, however, if furnace condition is good and alloy heats are scattered or alternated with the less difficult grades.

Since steel making by flush heat method is one using higher percentages of hot metal than the ordinary scrap and iron method, some evaluation of iron percentages is obviously necessary. Figure 9 reflects the varying percentages of hot metal and its effect upon tons per hour. There are mixed opinions about the results that can be accomplished in high or low iron percentages on flush heats, but in this study the best results show up equally as well at either end of the chart. Results on 4 per cent of the heats made with 53 to 54 per cent metal charge exceed the operating rate of the next 48 per cent charged with 55 to 60 per cent iron. The results on the remaining 48 per cent of the total heats made then show a gradual upward trend. This seems to clearly indicate that the intermediate iron percentages should be avoided to obtain maximum tonnage.

If a limited amount of hot metal is available to the open hearth for charging, for example: 54 per cent of the charge, best results are probable by spreading the metal to all of the furnaces rather than favor some and penalize others with a greater percentage of cold charge. Ingot yield will benefit by spreading the charge, as will be pointed out in the next part of this discussion. The percentage of metal used governs to a major extent the amount of charge ore or sinter to be used, therefore no evaluation of the use of these commodities is necessary.

Figure 10 indicates the trend on ingot yields as plotted against the scale of increase in iron percentages used. The decrease in ingot yield is more pronounced on the chart at the lower range of iron percentages than at the higher because of distribution. In the lower range up to 56 per cent iron, the tonnage made constitutes only about 17 per cent of the lot, whereas about 83 per cent falls within the higher ranges. The trend of decrease in yield is very clear, however, and it may be seen that approximately 1 per cent lower yield is experienced between the heats made with 64 per cent iron over those made using an iron charge of 54 per cent.

Figure 9 — The yield in tons per hour is at a minimum when the iron percentage ranges from 55-60 per cent.


15.20
15.00
14.80
14.60
14.40
14.20
TONS PER HOUR INDEX
APPROXIMATE NUMBER OF HEATS MADE CHARGED IN THE RANGE OF IRON PERCENTAGES LISTED BELOW.
4.0% 13.9% 18.2% 16.7% 18.2% 22.2% 2.8% 3.0% .8%
53-54 55-56 57-58 59-60 61-62 63-64 65-66 67-68 69-70

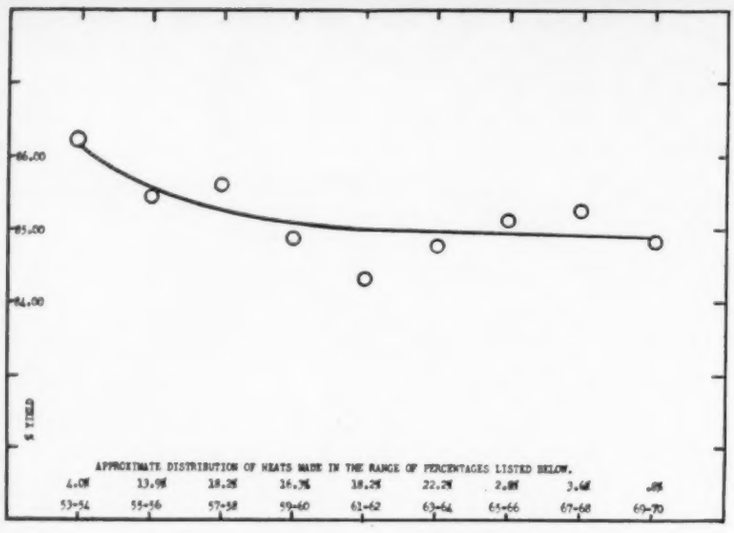


Figure 10 — As the percentage iron is increased, the ingot yield is decreased.

This difference of 1 per cent in ingot yield is important to watch for economy in practice. Maximum tonnage can be lowered substantially, with affiliated increases to ingot cost. With scrap and iron prices at $16.00 per ton, 1 per cent loss from ingot yield penalizes costs approximately $0.18 per ton of ingots. To a shop making 2,000,000 tons annually, this would amount to a sum of about $360,000.00 to say nothing of the approximate loss of 20,000 tons of ingots.

In comparing practice in making steel by the high iron flush heat method with that on regular scrap and iron heats, a few other relative facts must be brought out. With the scrap and iron heats, which usually are 40 to 45 per cent hot metal charged, this leaves 55 to 60 per cent of the heat which is scrap or cold charged materials. Flush heats are made with a range of 55 to 80 per cent iron depending upon available hot metal, and have correspondingly much less scrap or cold charge. This gives a decided advantage to making faster heats. Lower lime requirements also contribute to the speed in making these heats. With proper coordination of all attendant functions, this advantage may gain from 10 to 20 per cent more production, depending upon the types of steel to be made. There is, however, a disadvantage to be overcome in the form of lower ingot yields. This may amount to as much as 3 to 5 per cent lower yield depending upon how well the flushing practice can be maintained. As in the making of steels by any process, the composition of the charge materials plays a very important role. The quality of the ingot tonnage compares favorably with that made by any method, and in many cases, better products for rigid specifications have come from ingots made by the flush heat method. This experience has been proved to be true in making steels for the ballistic requirements needed by the Army and Navy.

CONTROL OF QUALITY

Meeting quality standards in open hearth practice goes considerably further than control of chemical analysis. Chemistry to meet customer or standard specifications, of course, must be given greatest possible attention. Competition of trade creates this demand. Off-heats must therefore be kept under control by systematic procedure to approach the first step in control of quality. There are numerous means or applications that can be used to help insure this control, but none any more effective than personnel performance records on off-heats. These reports summarized daily or weekly and distributed to all responsible personnel have proved effective enough to become an essential part of routine procedure. When distribution has become established so that individual effort can be watched, the frequency of off-heats will be seen to decrease materially. Once the ingot chemistry is under control, the ground work for quality has been laid. Follow up procedures in pit practice, cleaning, rolling, heat treatment, etc., will then be better served with a background of sound ingot chemistry.

The application of statistical control methods to operating practice in recent years has done a lot to curtail scrap production and improve quality. By establishing desirable control limits on practice dev ation poor quality products have been prevented going through the process line to inspection, thus saving valuable time spent on these products. This effort has meant tremendous savings in production costs and a reduction in customer claims. A great deal of literature has been published dealing with the application of statistical quality control methods in industry, and recently the War Production Board sponsored many classes under competent instructors, to promote greater use of sound statistical methods in the many types of industry which were engaged in war work throughout the country.

DISCUSSION

PRESENTED BY

R. E. DIENST, Production and Cost Analyst, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

A. E. REINHARD, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

D. C. PRICE, Executive Industrial Engineer, Bowser, Inc., Detroit, Michigan

E. C. WHITE, Metallurgist, Ford Motor Company, Dearborn, Michigan

A. F. DANZER, Superintendent, Great Lakes Steel Corporation, Detroit, Michigan

H. F. LESSO, Control Metallurgist, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

L. R. MILBURN, Electrical Engineer, Great Lakes Steel Corporation, Ecorse, Detroit, Michigan

P. E. HAGLUND, Melting Superintendent, Ford Motor Company, Dearborn, Michigan

FRANK G. NORRIS, Assistant Metallurgical Engineer, Wheeling Steel Corporation, Steubenville, Ohio

Member: What is the depth of the baths of your furnaces?

R. E. Dienst: There are some furnaces constructed with a longer bath than others to permit a lower metal line. I am not familiar with the depth dimension, but I am sure Mr. Reinhard can answer that question.

A. E. Reinhard: Approximately thirty-three inches.

Member: Regarding chart No. 2, how many heats are involved in that group? What is the group size?

R. E. Dienst: In this particular case, there were approximately six hundred heats plotted both as to ingot yield and heat size, and of course, plotted to mathematical scale, showing the progressive change in values.

Member: Is each charge of equal size shown by each dot on the chart?

R. E. Dienst: That is not true. The distribution follows a normal bell shaped pattern of heats made by varying charged weights, and of course there are far more heats that fall in the range from 520,000 to 540,000 lb with a fewer number of heats at either extreme end. Nevertheless, the trend is plotted to show the economic point in charging.

D. C. Price: The table indicates that accurate measurement of the fuel is vital. It also indicates on furnace No. 2 100 per cent more oil is used by one operator than by the other operator. Is this correct?

R. E. Dienst: Refer to Figure 4. No. The total fuel consumed at that point is about 430 gallons per hour on the average. The operator on A turn used slightly over 460, a difference of 31 gallons per hour.

D. C. Price: It is understood you would be unable to obtain the records making up these tables without accurate meter readings?

R. E. Dienst: You must have the meter readings. Our fuel department makes these readings, so that the information is available to make the determinations.

E. C. White: Charts, as well as being accurate, must be presented uniquely, so that results can be seen readily, amplifying the subject in such a way as to attract attention.

Mr. Dienst has definitely "hit the nail on the head" in the above statement. Who among us have not seen charts that represented many, many hours of statistical preparation on an important procedure but with no practical eye appeal? Chart lines would be light and too numerous; scale used so large as to make marked variations appear of minor importance; one chart is expected to convey far too much information, thus leading only to greater confusion.

The point is well taken by Mr. Dienst that charts to be effective should be: 1. Bold in outline; 2. Specific in data covered; 3. Developed with that eye appeal in putting the message across, which, after all, is the object of preparing data in the chart form.

The block type of chart as used in Figures 3 and 4 on fuels, is particularly effective, even more so, I believe, if drawn solidly to the base line or the norm, as the case may be. We have found this effective in personnel work, absentee control and it results in getting a clear idea across quickly.

Charging practice — The data on the effect of bulky scrap causing delayed charging and a corresponding loss in tons per hour is well known to all, but carries with it an additional point in favor of the heavier charge, i.e. the ability to calculate to a much closer melt-down carbon, this being additionally favorable to as heavy a type of charge as is practical.

Production data — The tabulation of production data we have found to be one of the most difficult jobs due to variables mentioned in Mr. Dienst's paper. If one sets out to plot furnace tonnage efficiency, he is at once confronted with the question, "what type of steel was made by the specific furnace in question?" It is well known that the open steels and rimming steels run easily ten to fifteen per cent shorter than the alloy type which are more slowly ored down and then blocked to allow for addition of alloys, thus requiring an additional one to two hours to complete a heat.

Does not this then require a separate curve plotting the furnace efficiency in consideration of the type of steel made? You would then have to break down the furnace production into general types: 1. Carbon heats, tapped wild or blocked in furnace; 2. Rimming heats, medium and low carbon; 3. Alloy heats, etc.

This need not be considered cumbersome as it will point up the true efficiency of a furnace in any specific period of its campaign. I would like Mr. Dienst to discuss this further, if time permits, as in our practice many types may be made on the same furnace in daily production.

Charged weights and ingot yields — Figure 2 is a splendid example pointed out by Mr. Dienst, of statistics bringing out a condition that would not ordinarily be expected, i.e. tonnage is not necessarily gained by overcharging a furnace with either scrap or hot metal. Many a first helper, having seen this curve, might well have thought twice before he slipped in those two or three extra buggies of scrap.

Fuel practice — This chart is a capable job of taking into account many of the variables affecting fuel consumption which shows a predominant advantage for No. 3 turn over No. 2 and No. 1 turn in maximum fuel economy. Would this indicate a more fuel minded supervision on No. 3 turn or could this average out over a year?

It seems to me that a charge to tap fuel record is the basic chart and truly representative of: 1. The furnace; 2. First helper and 3. Burner and fuel efficiency. Fuel used from tap to charge and fuel used on bottom repair, heating up, etc., tend to cloud the fuel problem and are results of entirely separate furnace conditions.

I would like to hear Mr. Dienst's viewpoint on this as it deals directly with much variation in fuel data published from time to time. It is my belief that fuel efficiency is the result of the operator, the furnace and controls and the burner design and type of fuel used. Bottom delays, heating up, etc., are entirely production problems irrelevant to fuel efficiency.

The most startling savings in fuel per ton, of course, are in reduction of the time of a heat, which may well bring out the importance of good melt-downs and quick recognition by the first helper of furnace melting conditions which may delay his heat. He, above anyone else, often has the opportunity of paring off one to one and a half hours on his heat with a consequent saving of 10 to 15 per cent on fuel.

Scrap segregation — Mr. Dienst's table of facts on possible recoveries from scrap and the dollar and cents value of same is certainly apropos of the open hearth problems of today. I am sure he would like to spend a complete evening on this topic alone, with advantage to all of us.

One of our present problems appears to be not always a recovery of these valuable metals but keeping them out of our steels. Keeping these tramp elements out of sheet steel, etc., of course, is recovery in reverse, I suppose.

A short discussion on the best methods of sorting the variable scrap coming to the open hearth today would be in order, time permitting. It is obviously a question of balancing the cost of segregation, identification, etc. against the gain in recovered alloys or the cost in rejects in fabricated parts due to the harmful effects of unwanted residuals.

The effect of silicon in the charge — This chart is very interesting and brings out the important part slag volume plays, which fact is often underestimated. It is clear here, and corresponds with our practice, that higher silicons, although compensated for in calculating heats, do generally put a burden on production.

Roof life — The data on roof life versus alloy heats is comparable with our practice and would, I believe, indicate the advisability of finishing the latter half of a campaign on a roof with types less strenuous on the furnace, such as medium carbon rimming heats in order to obtain maximum roof efficiency. This scheduling is not always possible, unfortunately, due to demands of the mills.

Flush heats — The information given by Mr. Dienst in Figures 9 and 10 would show the inadvisability of running part of a group of furnaces at 65 per cent hot metal and the balance regular scrap or partial cold iron charge. As shown by the chart, representing sufficient number of heats to be reasonably conclusive, it would be better business to put the whole shop on 55 per cent flush heats, taking advantage of the optimum ingot yield as well.

Control of quality — The off analysis chart mentioned here is definitely a competitive chart and certainly effective among the melters. This question of competitive effort leads one to wonder if we have even scratched the surface of first helper competitive psychology. The quality of steel produced, the time of the heat, the life of the furnace roof and the complete campaign on the furnace proper, all of extreme importance in production, are substantially in the hands of the first helper.

Is it not possible that a more personalized statistical method of appeal might well be necessary to have each furnace operator functioning at the top of his skills? This would also result in an increase from day to day in his knowledge of the metallurgical phases of steel making. A discussion on this angle will be helpful along both quality and production lines. The following questions summarize the above discussion:

1. How would one determine the true tonnage capacity of a furnace on mixed types of steel?
2. Does not the charge to tap fuel tell the efficiency of first helper, furnace, the burner and fuel? Isn't additional data irrelavent?
3. Statistics on the control of tramp elements, Cr., Mo., Cu., Sn., etc. in steel are also of extreme importance and would benefit by discussion.
4. What are the possibilities of personalizing the statistics further, to invite top effort by the first helper toward sound metallurgical practice.

R. E. Dienst: I might make some brief comments regarding the attempt to keep records on first helpers. I don't know how your records are kept, but on ours, the chemistry, is charged to the melter, and he watches his record quite carefully. If he is charged with an off heat which, in his opinion he is not responsible for, he will kick about it. If the first helper in any case may be at fault in causing the melter to miss his heat, because of excess temperature or any other condition which may exist, I think he will take care of it properly. There might be a way to develop an efficiency report which would include first helpers. Just how, I wouldn't know, because we have always charged the melter for bad chemistry. Of course, he is given certain ranges to work in, carbon usually three point range, ten points on manganese, ten points on silicon, ten points on chrome and three points on molybdenum, and as long as he confines his practice to these limitations, chemistry is acceptable.

Member: Would it be too impertinent to ask you about what your efficiency is?

R. E. Dienst: When we first started keeping the records, the percentage was high enough to warrant an accounting.

Now, our percentage of error runs possibly in the range of from six to eight per cent, and if it goes much beyond eight there is usually somebody quite concerned about it. This is a fairly good record, I think, on off heats.

Member: When you first started to keep these records, was the process new to the melters, or had they been accustomed to them?

R. E. Dienst: No, they had been accustomed to off-heat records before, but the practice of keeping them had been discontinued for a period of time, and it became more important with the greater per cent of alloy steels required by the customer, and was necessary to start them again.

Member: Who keeps these records, the melters themselves?

R. E. Dienst: No, they are kept in the office. It is a matter of importance in keeping them consistently. If you let up for a while, they lose their effectiveness.

Member: This is all leading up to the system of tabulating machines, which we use.

R. E. Dienst: That is very fine, if you have I.B.M., it is the thing to use. You can do so much more with it than you can manually in the same amount of time. We use I.B.M., but keep most of our records manually. Our sales analysis department uses I.B.M. for sales classifications, end use of products, and other distributions.

Member: To whom do these charts go, just the open hearth people, or do the general superintendents get them too?

R. E. Dienst: Most of the charts that are made have a distribution to as many people as they can be found to be useful to. For instance, Figure 3, which illustrates the fuel and operating practice, is made accessible to top supervision, open hearth supervision, and of course the fuel department, and anyone who has use for them. They are usually made monthly, as are many of the other charts which are distributed in the same way.

A. F. Danzer: In line with what Mr. Dienst was saying with reference to Figure 3, is that made available to first helpers?

R. E. Dienst: The first helpers have access to it through open hearth supervision, who receive the chart monthly. That is the purpose, to put the information in the hands of those who can use it best. Their discretion must be used in matters of discussion.

A. F. Danzer: Well, you do have a regular report that goes to the open hearth floor, don't you?

R. E. Dienst: We have a board at the control panel of each furnace upon which is recorded daily the cumulative monthly operating and fuel rates, so the first helpers and all operating personnel on the floor are kept informed of their practice from day to day.

A. F. Danzer: Mr. White was speaking about segregation with regard to the elimination of the alloys. He used that chart in a little different way, I believe.

R. E. Dienst: My illustration was purely to show the economics of it. Scrap segregation is a subject which could consume a whole evening in discussion. The chart shown was briefly to point out the economic value of scrap segregation in keeping down alloy tonnage costs. The illustration shows in table form, by points of residual alloys, the savings which can be effected by commodity. The presence of undesirable alloys in carbon steel scrap presents a difficult problem, which no doubt could have been prevented by proper segregation.

A. F. Danzer: Do you have a chart showing efficiency gained by the type and distribution of scrap charge? You mentioned the variables of charging materials.

R. E. Dienst: For the purpose of preparing this paper no data regarding this phase of practice was used, but we have someone with us in this group who has made extensive studies of various types of scrap and their effect upon operating practice. Mr. Lesso, would you care to give us your thoughts on this subject.

H. F. Lesso: As I understand your question it is relative to the distribution of scrap of various physical classifications in the furnace charge, is that correct?

A. F. Danzer: Yes.

H. F. Lesso: An extensive survey made relative to the influence that distribution of scrap of certain physical classifications had upon the production cycle of an open hearth furnace found it to be of definite importance. The established relationships become more important when plotted versus total charge silicon.

The study revealed that with a total charge silicon of approximately 0.40 per cent of the total furnace charge as little as 5 to 10 per cent light scrap contained in the furnace charge permitted of good production rate. With increasing charge silicon, it is necessary to increase the per cent of light scrap in the furnace charge. The difference in light scrap requirement amounts to an increase of approximately 25 per cent between 0.40 per cent charge silicon and 0.70 per cent charge silicon. The technical interpretation of these findings has an oxidation-reduction aspect. These quantitative relationships will of course be altered by charging conditions, meltdown conditions, etc.

L. R. Milburn: As far as electrical engineering is concerned, all I can say is that charts in electrical engineering are things that we must have if we are to know how to operate. We have to know what the past trends were, and we have to know what the curve is to enable us to plan for the future.

His method of plotting his material on charts is far superior to trying to read a lot of statistical theory. If you have a chart you can see just where your curve is going and what your trend is.

P. E. Haglund: I would like to ask Mr. Dienst how he tabulates the records and the off heats against the melters on a forced tap or a delay due to the pit. Do you make any allowances?

R. E. Dienst: We do not charge a melter with an off heat where the chemistry is bad on a forced tap, because he has no control over that; neither do we give him an off heat for anything that happens in the pit, such as steel breaking through the runner. Anything that happens which is beyond his control is an off-heat but the melter is not charged with it.

H. F. Lesso: The value of correlation analysis has long been recognized as an efficient medium through which production trends and pertinent relationships could be readily identified. As early as 1924, Dr. W. A. Shewhart of the Bell Telephone Laboratories recognized the need for data in statistical form to determine the efficiency of manufacturing methods and processes.

It has been generally reported that the more progressive of the current process industries by reason of their comparative youth, interest in efficient operation, and freedom from the empiricism of older producing groups suffer somewhat less from unnecessary costs than the general run of industry.

Since Dr. Shewhart's development many valuable and excellent writings have been published. In addition to numerous textbooks, current trade journals have carried articles of a highly informative nature. Among the more recent being Iron Age of May 11, 1944 and Metals and Alloys of October, 1945 with a selected bibliography. Another interesting publication is that by Lt. Charles M. Mottley of the American Society of Naval Engineers. The Research and Standards section of the Bureau of Ships found that by observing performance trends on the various types of steel they were able not only to replace vital alloying agents with secondary materials but also to reduce the alloy requirements by one-third and still produce a quality and reproducible product.

Mr. Dienst's writing has dealt with control. What do we mean by control? If we are going to determine when any one or more phases of the process are out of control we must have some accurately defined limits. I should like to ask Mr. Dienst if he will briefly describe the theoretical background in establishing control charts.

R. E. Dienst: Statistical quality control methods that were developed by Dr. Shewhart evolve around the principle of frequency distribution caused by variation in a repetitive process or practice.

The frequency of occurrence of things within a process show a more or less varied amount of inconsistency. It is impossible to make two identical articles by repetitive process, or to follow a path of desirable practice without considerable variation. Wide variation in the process of manufacture must be controlled to obtain maximum efficiency and achieve minimum waste in effort and materials.

In making a frequency distribution of the occurrences of a phase of practice, approximately 68 per cent of all

variation will be seen to be confined to the central area, one standard deviation either side of the mean. Two standard deviations either way will collect 95 per cent of all variation, while three standard deviations will incorporate 99.7 per cent of the whole, the latter (3-sigma limits) accounting for most all variation except chance causes which may fall outside the above stated limits.

Since this is fact and not theory, it is possible to evaluate a process quite accurately, establish mathematical control limits, and eliminate much variation. When certain assignable causes for variation occur, they can be easily detected on control charts. Random selection and systematic sub-grouping of data make it possible for a very small portion of the entire lot or process to give a reasonably true picture of the whole. Once a process level has been established it is of course necessary to use diligent effort to remove each and every assignable cause of variation and, if possible, narrow the control limits for future performance, in the effort to follow a straighter path and achieve the greatest possible amount of success with the idea.

This practice has recently been adopted extensively by the steel industry, particularly during the past war. There has been, of course, a varied amount of success in using the idea, and I am sure we have people here tonight who have been using it for some time. Possibly Mr. Williams or Mr. Norris might have a few contributive thoughts on this subject.

Frank G. Norris: It is difficult sometimes to comprehend the good, sound, solid information and hard work there is in one of those charts. One of them, for example, is based on nine thousand heats. That is a lot of heats and represents a long period of operation, probably over a year.

The general theory is that one man concentrating on the preparation of charts is saving a lot of men from just standing over a bunch of figures and not grasping more than just a few of the highlights that happen to be involved in the table. That is the justification for it, and I am certain that that is the way it has worked out. It is humanly impossible to get very much information out of a table, but at a glance you can see relations on a chart.

Now Mr. Lesso has put his finger right on the nerve center of this situation. In other words, these trend charts are an introduction; they are a good starting point to find out the conditions that you want to have with respect to the factors that you have mentioned. You study the fuel, you study the production rate, you study the analysis efficiency, if you please, or some other objective measure of quality or measure of performance, and you relate those to the variables that are found to be important. Then you find that you want to hold to a certain average condition in order to favor high production, or quality. How to do this involves control charts and is the next step after defining the desired conditions. I think that is the question that Mr. Lesso has in mind. The question is, "How can you do that?" After establishing that you want to duplicate a certain portion of a curve, how can you be sure that that is what will happen?

One way is to have the fellows try harder. You put it on a competitive basis, let them race against each other. In other words, by using psychology and such incentives, make them try harder.

There is a limit to that, what that limit is, how close they can come to uniformity, depends on what you give them to work with. It depends on how sharp you want to sharpen your pencil amd how fine a line you can draw. There are certain inherent limitations in any process. You find that out on machine tools. If you have an old, wobbly machine, you are doing pretty well to hold to maybe an eighth of an inch or a sixteenth of an inch. That is not good enough these days; you have to hold a thousandth, sometimes closer than that. But there is a limitation imposed by the equipment. In the stock house, there is a limitation inherent in your scales, on how close you ought to expect to weigh a heat.

The answer to the question of accurately defined limits is also contained in the figures, and it is a matter of juggling a little bit, and making a little more use of the data.

It is a matter mainly of being able to discern when the variation is great enough to worry about? When is it something that we cannot hope to eliminate? There are those two kinds of variations, and they depend on the equipment and methods involved. A control chart set up properly related to the process will show the effect of causes that can be removed. When all such causes of variation are removed, we have what is briefly described as control.

Really, though, that is the second chapter. We have had a very good introduction this evening, and we hope that Mr. Lesso will continue his studies and come along some time and deliver the answer to the question that he has propounded.

Vosburgh DISCUSSION

(*Continued from page 67*)

1,400 Btu per square foot per hour. The heat lost through ceramic lining, originally made 32 inches thick, and presuming it would stay at that thickness, was about 900 Btu, but ceramic lining never does stay as originally installed, so we assume that over a period, say weeks or months, the average thickness has reduced to about one foot. In that case, the heat lost through it would be about 2,400 Btu, or approximately double what it would be through carbon lining. That heat loss hasn't seemed to bother blast furnaces particularly.

We made computations on a lining made up of 19 inches of carbon and 13 inches of ceramic backing it up, and there the heat loss was about 1,130 Btu. When you calculate your fuel loss, it is about 2 pounds of coke per ton of iron, so the differential in heat loss is really inconsequential.

R. R. Thomas: What are the relative installed costs of carbon blocks and standard type ceramic blocks?

Frank Vosburgh: It is difficult to give any figure on relative costs. It will vary with the design of block used and other details. Carbon's first cost is higher than ceramics.

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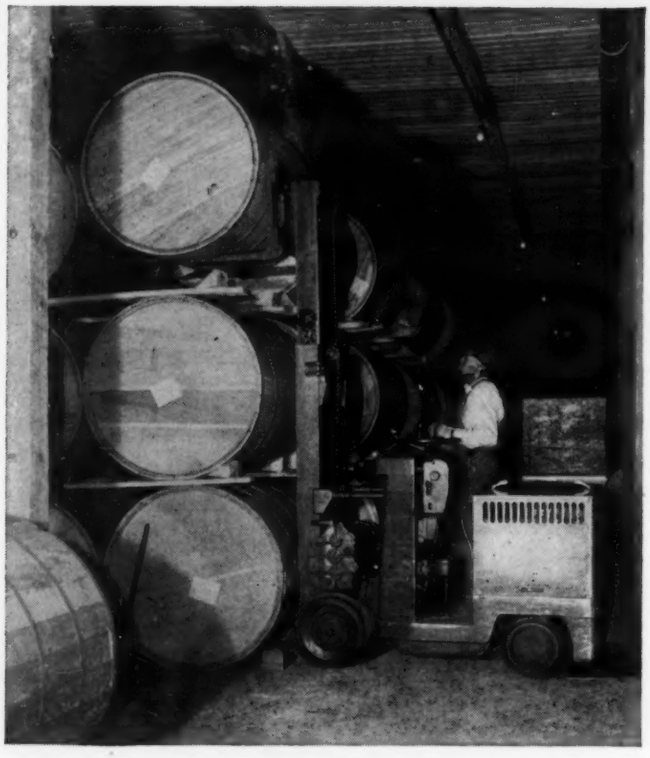
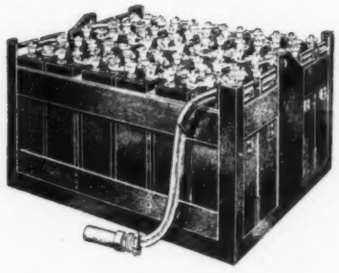


BATTERY TRUCKS work without "fussing and fuming"



...ALKALINE BATTERIES give most trouble-free power

THERE is nothing temperamental about battery industrial trucks. Battery power and electric-motor drives give them instant self-starting, rapid yet smooth acceleration, and quiet fume-free operation. This makes for safe tiering, safe handling of fragile loads, safe operation in confined quarters or in the presence of fire hazards.

In addition to instant self-starting, battery industrial trucks consume no power during stops. This makes for high power efficiency in the stop-and-go service that is inherent in material handling work. And the current used for battery charging is low-cost power.

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Altogether the battery truck is an inherently dependable and economical material handling machine . . . especially when powered by Edison Alkaline Batteries. With steel-cell construction, a solution that is a preservative of steel and an electrochemical principle of operation that is fool-proof, alkaline batteries are the most durable, longest-lived and most trouble-free of all batteries. Edison Storage Battery Division of Thomas A. Edison, Incorporated, West Orange, N. J. In Canada: International Equipment Company, Limited, Montreal and Toronto.

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ROLL-NECK BEARINGS

WEIRTON STEEL COMPANY
CASE HISTORY NO. 1

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These are the facts from Weirton Steel of the benefits obtained from the G-E Textolite roll-neck bearings installed in this two high, four stand, tandem cold strip mill.... Add them up and the answer is fewer production headaches and increased profits.

It's because Textolite roll-neck bearings are water lubricated that large savings on grease are possible.... trouble-free and long bearing life is assured by simply maintaining a sufficient flow of water on the necks.

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THE Wellman-Dean is a new patented pit which was developed after a close study of the merits of all other types of Soaking Pits. It is the finest that the most complete engineering information regarding all pits built in the past could make possible. Note these features:

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6. Utilizes to the fullest extent the outstanding advantages of luminous flames for either gas or oil.
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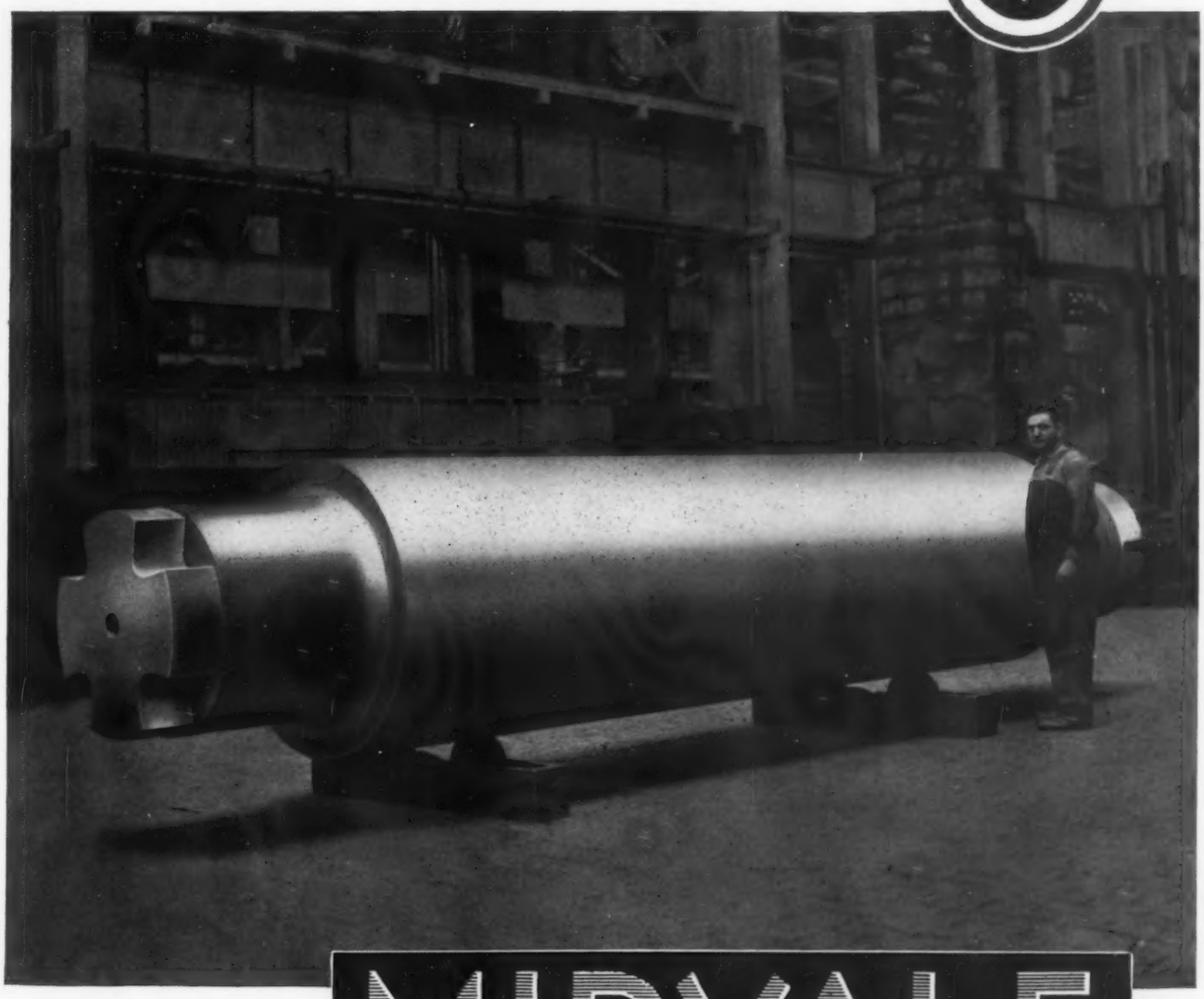

One of eight plants to retain original Navy "E"

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Custom Steel Makers to Industry

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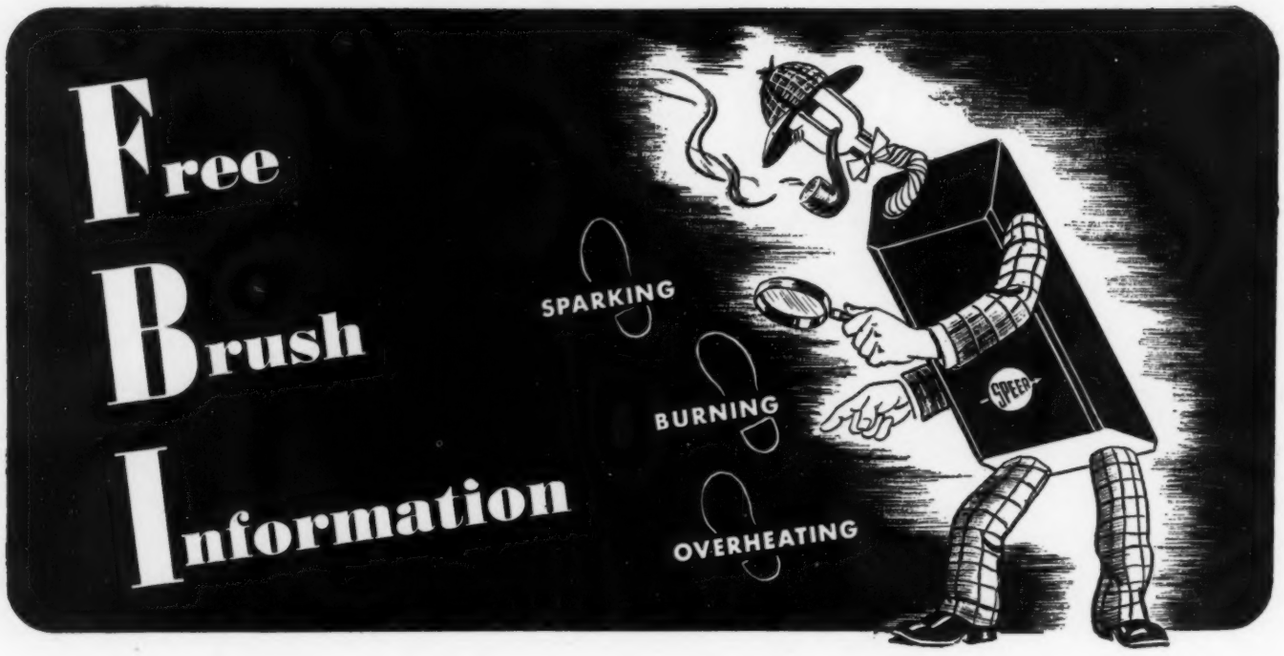

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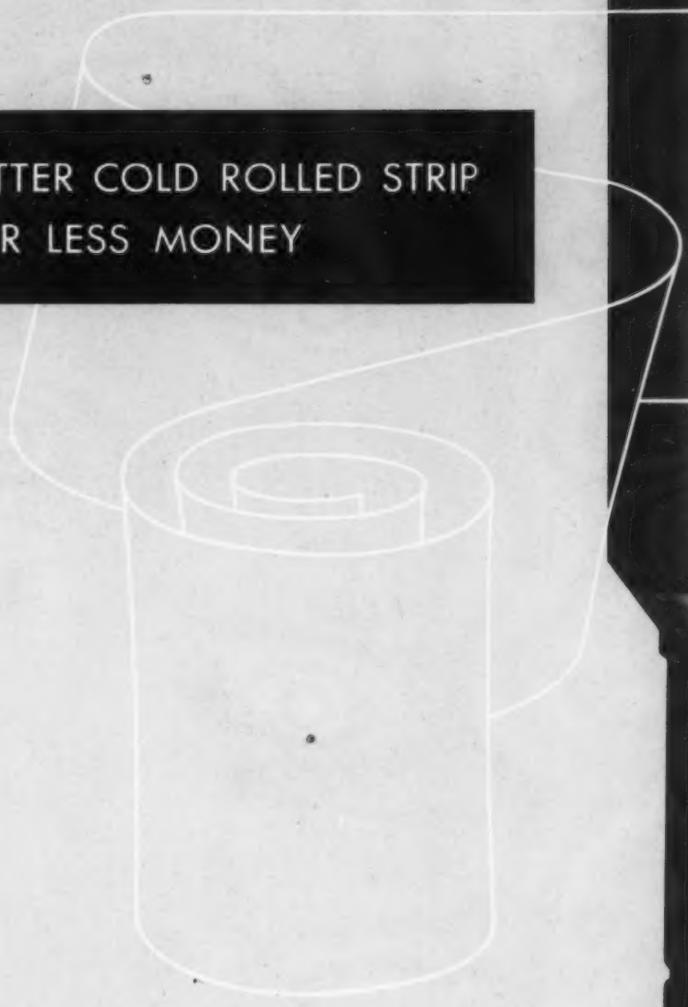

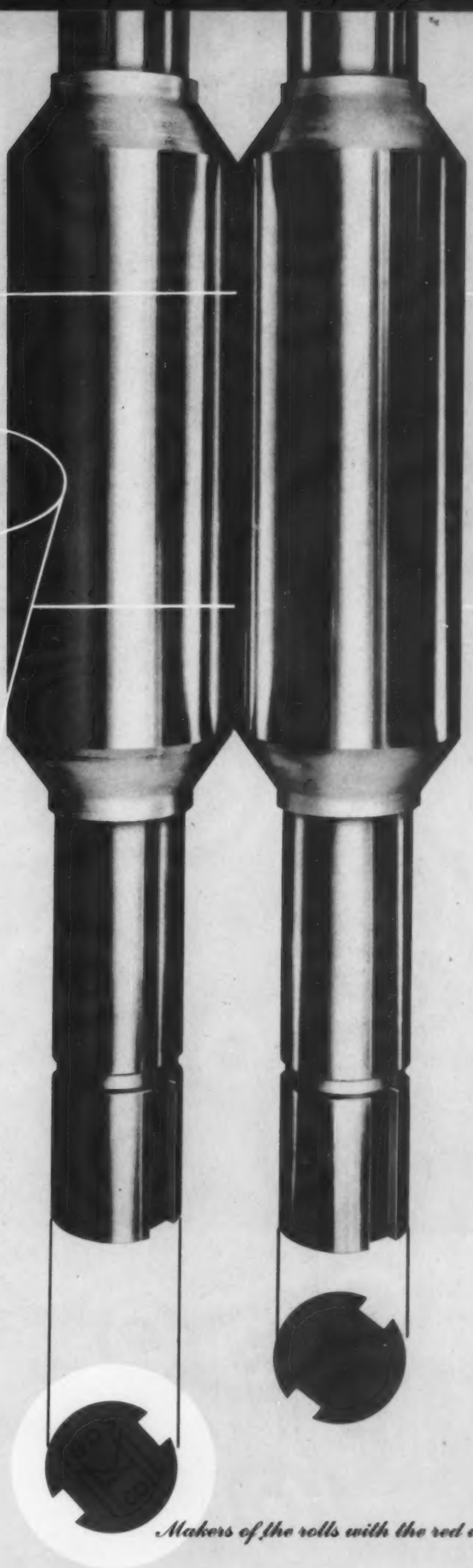

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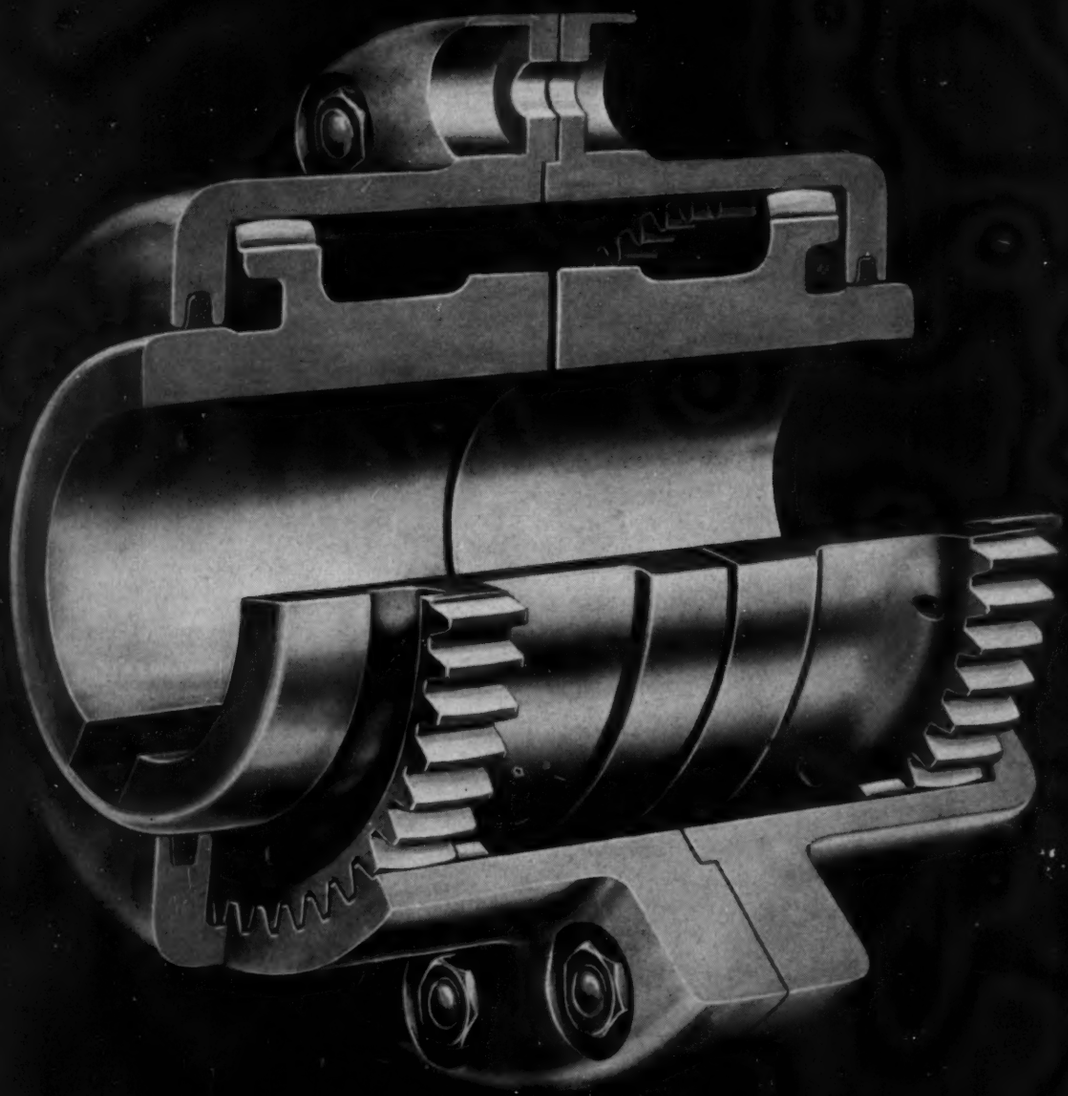

A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

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POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

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Mill Superintendents quickly recognize money-and-time-saving advantages of the new Bonnot Inspection Table. Whenever quantity inspection occurs, this rugged and efficient equipment speeds up bar and billet inspection . . . keeps production running with assembly-line smoothness.

Hydraulic manipulators easily enable one man to handle complete inspection . . . and do it quicker than is possible with older, time consuming methods.

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Increase productiveness of your Billeteers with this new table. By feeding a battery of Billeteers from one inspection table, you eliminate chipping dead-time occuring during billet inspection on roll table.

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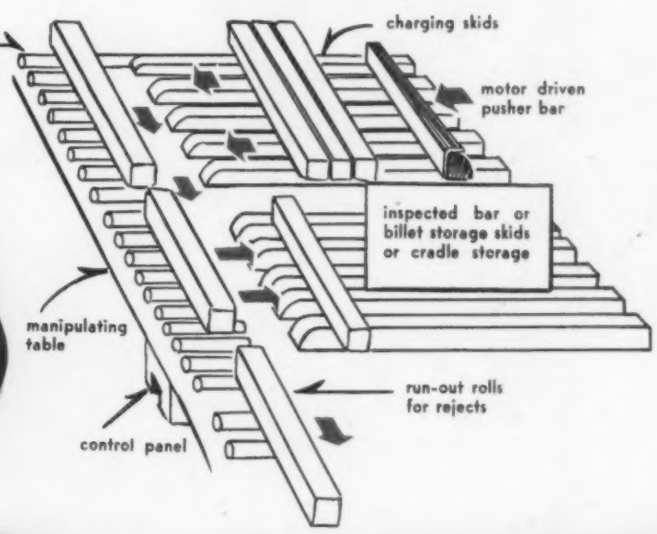

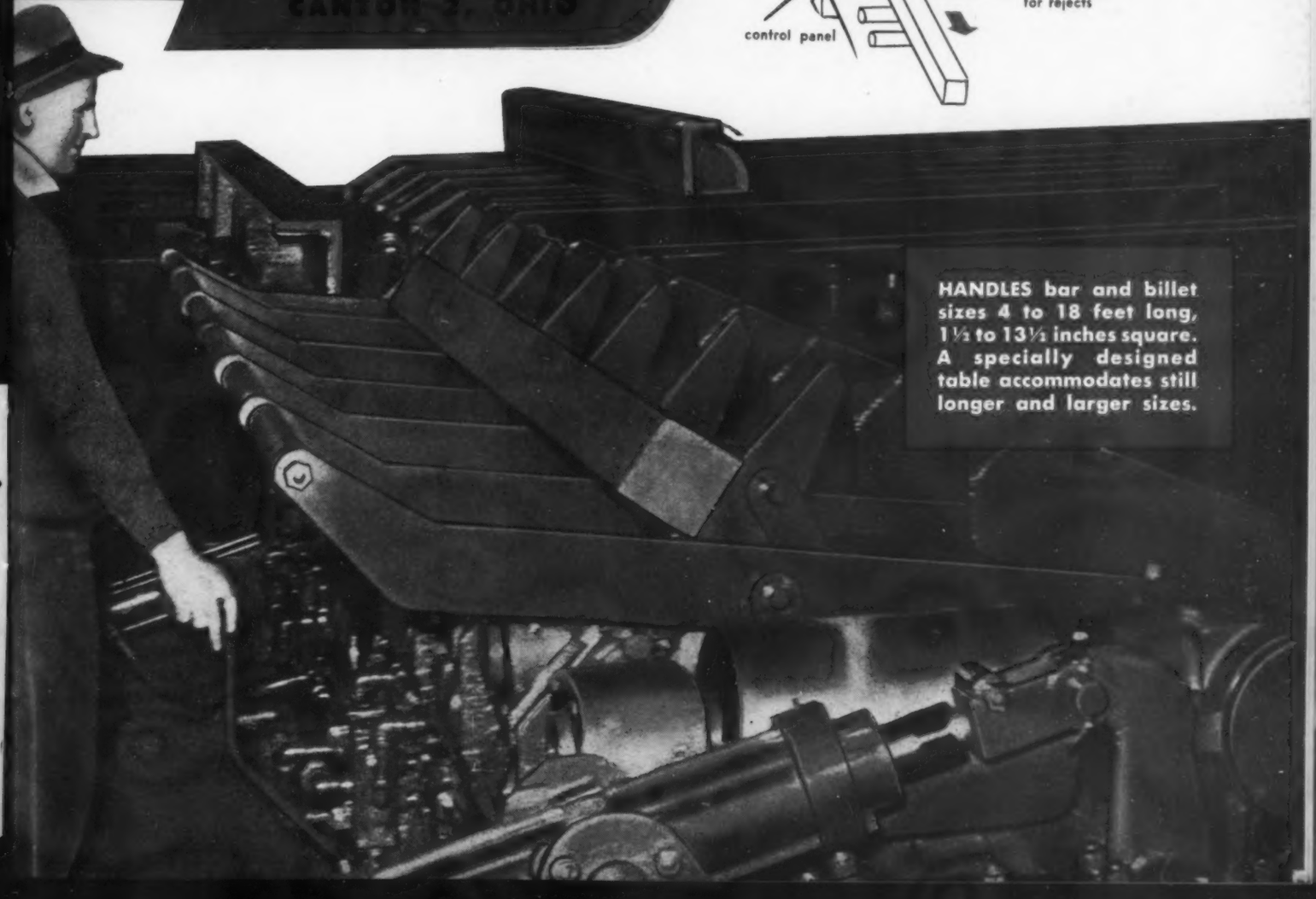

HANDLES bar and billet sizes 4 to 18 feet long, 1½ to 13½ inches square. A specially designed table accommodates still longer and larger sizes.

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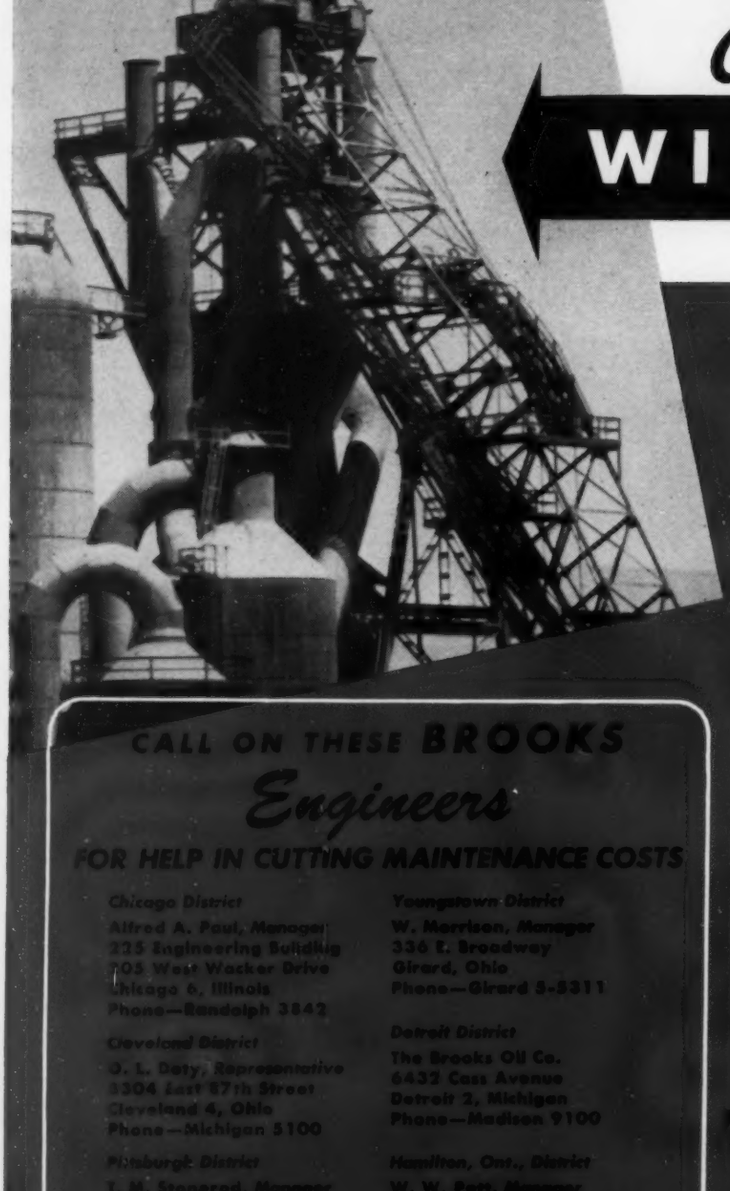
THE ★"I. P." LUBRICANT

Stops costly Corrosion on

WIRE ROPE



WIRE rope lubrication is divided into two classifications—*Lubrication* and *Protection*.

Lubrication provides an oil film covering of all surfaces, preserves the hemp center so that its elasticity and resiliency are retained, and prevents "corrosion pitting."

Protection preserves the lubricant and seals the rope. It prevents moisture and corrosive influences from penetrating into wire and strands.

TWO to FOUR TIMES the service of ordinary lubricants, under normal conditions, is the record set by "I.P. Leadolene" in the lubrication and protection of wire rope from wear when exposed to dust, ore, sand, coke, coal, water, mud and other abrasives. These lubricants adhere and penetrate to the hemp core. "LEADOLENE" characteristics provide an *Indestructible pH-film* between the strands and wires. On the inside, where most failures occur, "Leadolene" does not wear off, and is unaffected by air, rain or snow.

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NEWS SUPPLEMENT May, 1946

Equipment
Personnel
Literature

Iron AND Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

ELECTRIC TRUCK ASSOCIATION TELLS HOW TRUCKS SPEED OPERATIONAL FLOW

▲ How the orderly flow of operation in a basic heavy industry — from production through shipment is made possible through the use of battery-powered industrial trucks, is exemplified in the $30,000,000 strip mill of the Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. Here, in blocks long buildings, a fleet of eighteen of these trucks of various types, sizes and capacities, safely lift, move and place huge coils of strip steel, or "flats" of sheet and plate, in weights up to 23,000 pounds, at a speed geared to the production schedule. The coils are moved from the rolls to cooling piles, then to the finishing departments, then to stock piles or to trimmers, again to stock and finally to the loading docks and then aboard box-cars.

Many of these battery-powered trucks were designed and built for the specific heavy duties they are called upon to perform in this mill. They augment the powerful cranes that shuttle back and forth overhead, but certain of their functions, such as the loading of box-cars with coils destined for tinning at the corporation's works at Aliquippa, Pennsylvania, can be performed by no other type of mechanized, material mover, nor could these functions in any way be performed by purely manual means.

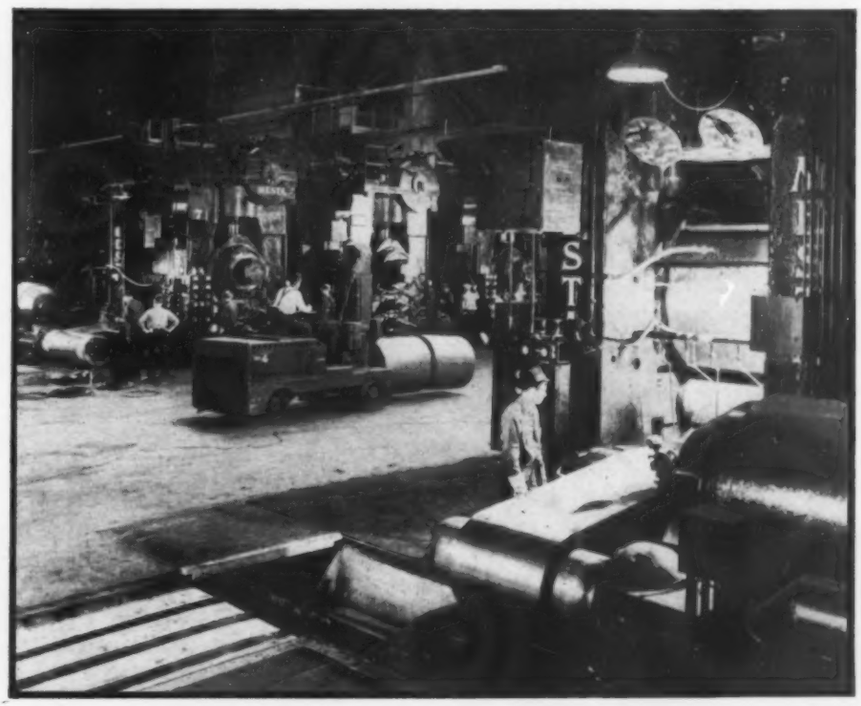
The cranes, too, carry "flats" of plate or sheet steel, both to stock and to the packaging department where wrappers and banders prepare the steel for shipment. Cranes also move the heavy rolls for replacement in the huge mills and move immense slabs of metal; but it is the electric truck, constantly and dependably moving about in runs of from 75 to 200 feet, that is relied upon to move and handle the bulk of the mills' product.

One operation alone, that of loading box-cars with coils of tin plate gauge, is performed by two battery-powered ram trucks. One delivers the coils just inside the car's doorway, the other places the coils, surely and exactly, in position inside the car. Swiftly the two trucks perform their respective functions, and it is only a matter of minutes before the coils, which are held in position by wooden bars and chocks nailed to the car's flooring, are ready to be transported to their destination.

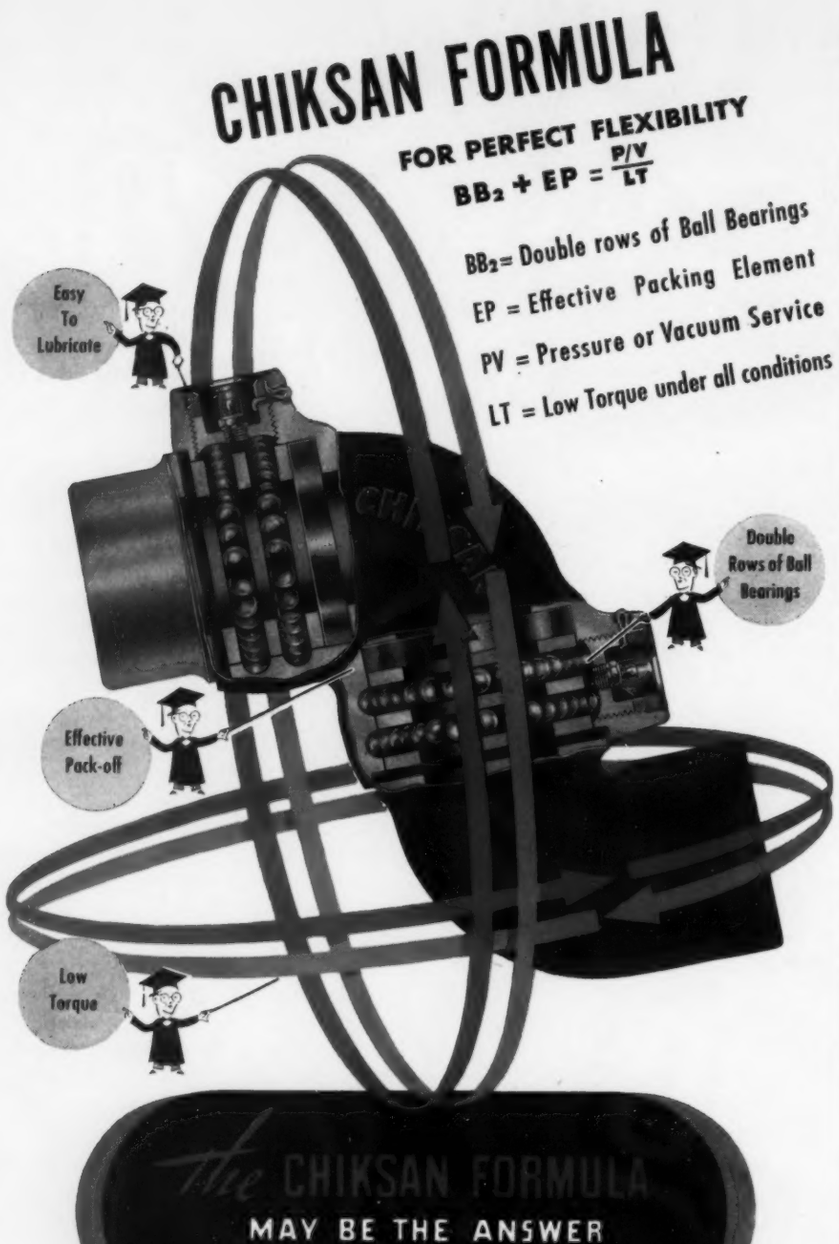
Originally the trucks equipped with rams, of from 36 in. to six ft in length, carried loads not much in excess of 6000 lb, although their rated capacity was greater. The weights of individual loads have increased during the intervening years, however, so that now coils weighing 15,000 lb, 20,000 lb, and even more, are being handled.

Up to the time the Jones and Laughlin Steel Corporation laid down its specifications for the type trucks it needed, and outlined the duties these trucks would be called upon to perform, electric trucks did not have rated capacities as great as those called for by Jones and Laughlin. It was known that no other type truck could meet the requirements, however. When these electric trucks were built they were regarded as the last word in this type of equipment. The original trucks, although still in use, are now out-rated by new acquisitions to the strip mill, some in use having rated capacities that permit them to carry loads of from 23,000 to 25,000 pounds at one time.

Large as these trucks are, and despite the heavy loads they carry, most of them are being operated by women at this strip mill. It was found during the war that women proved to be most efficient in their operation of the



An 18 truck fleet of various sizes safely lift, move and place huge coils of strip steel at speeds geared to the production schedule.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FOR PERFECT FLEXIBILITY
$BB_2 + EP = \frac{P/V}{LT}$
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EP = Effective Packing Element
PV = Pressure or Vacuum Service
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Chiksan flexibility is so precisely engineered that the elements which provide for easy turning and perfect seal under pressure or vacuum can be stated in a few simple symbols. This streamlined design, expressed in precision manufacture, has won world-wide acceptance for Chiksan Ball-Bearing Swivel Joints wherever movement or rotation is required in pipe lines handling liquids, vapors and gases ... in aircraft ... electronics ... railroads ... chemical and food processing plants ... refineries ... marine installations ... open hearth furnaces and rolling mills ... and hundreds of other applications. The new Chiksan Catalog illustrates and describes over 500 different Types, Styles and Sizes. Your Engineering Department should have a copy for ready reference.

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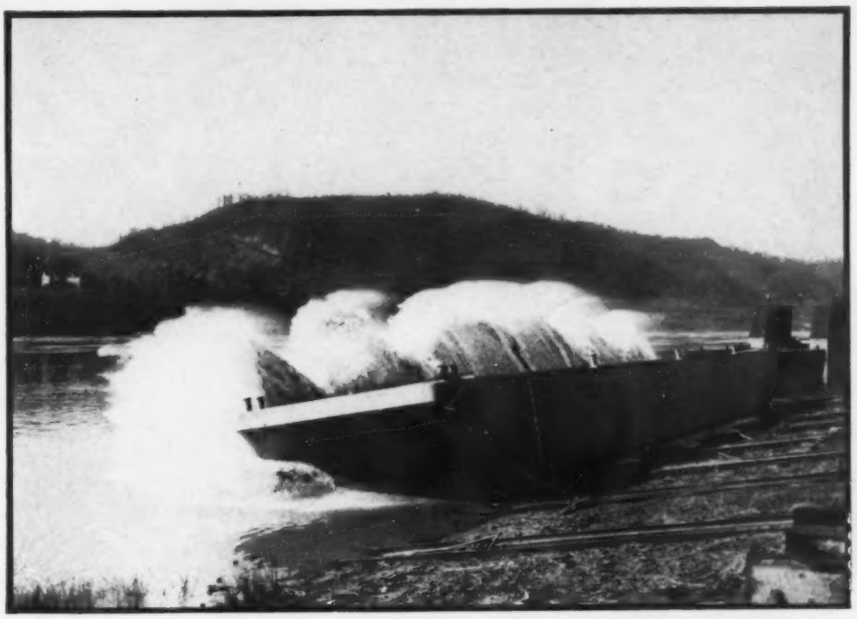
trucks, and take excellent care of the equipment they are given to handle. All freight car loading is done by male operators, however.

There is some talk of a battery-powered truck to be constructed that will have a rated capacity of 60,000 lb. This would mean, that the wheels would have to carry not only the full 60,000 lb load, but a counter-balancing weight of a similar amount, while the frame and mechanism to lift and move such loads would weigh at least 10,000 lb more, giving a weight on the forward wheels, at full load, of 130,000 lb. The wheels for this talked-of, battery-powered, truck would be twenty inches wide and thirty-six inches in diameter, and it would be the highest rated, as well as the largest and heaviest battery-powered industrial truck ever constructed. Flooring adequate to stand up under such loads would have to be especially constructed, but the cost of such construction, it is believed, would be insignificant when compared to the cost of construction of material movers of other types that would have an equal capacity, such as an overhead crane.

Since the loading of tin plate coils has never been done manually at the strip mill, no comparison of costs between hand and electric truck loading methods are obtainable. Nor are costs for the loading of box-cars with pallet loads, or "flats" of plate and sheet, readily available. However, when the mill first was opened, such loading into box-cars was done by a four-man crew, who handled a plate or a sheet at a time. These were piled, inside the car, then wrapped and banded. It took these four men approximately four hours to so load a car. Now, the material is moved in an integral load by a battery-powered fork truck of 4000-lb rating, to the packaging station at the loading dock. After wrapping and banding, the "flats" are moved into, and positioned within the box-car by the same truck, this work of loading being done by one man, the truck's operator, in approximately 45 minutes.

Within the cold strip mill, several of the fleet of ram trucks are kept busy feeding coils to the huge 54 in. and 90 in. tandem mills, while others move the trimmed coils, upon their emergence from the mills, to the stock piles. Because of the extreme weight of these coils, it has been found necessary to stock them not more than two tiers high. Thus, immense distances

RESUME STEEL BARGE MANUFACTURE



Sleek welded steel barges instead of LST's are splashing into the Ohio River these days at Ambridge, Pennsylvania, as peacetime production accelerates into high speed at United States Steel's American Bridge Company. This photo was taken not far from the Navy shipyard where the company built and launched 143 ships during the war, including 119 big landing craft and four ARV's, aviation repair vessels. Pictured hitting the water's edge is one of 75 new coal barges being built for the river fleet of Carnegie-Illinois Steel Corporation.

—E-15—

are taken up with horizontal, rather than vertical, storage.

The same system of storage is applied to the "flats" of plate and sheet. These, while they are piled three or four tiers high, with wooden spacers between the "flats," are spread out horizontally.

Despite the vast area occupied by the strip mill, space still is at a premium. Therefore overhead cranes are utilized to store, or move from storage, the "flats" within the center of the storage pile, the fork trucks working only at the outer edges. Manwidth aisles are left between the tiers of "flats" to permit passage of floor helpers who work with the crane operators, in attaching or releasing slings or grabs used in transporting the "flats" to and from the center of the storage areas. In some instances, when the "flats" have been moved from the center of the stock piles, they are placed at points where they can be handled by the battery-powered trucks. In other instances they are moved by crane to the packaging stations, and then are loaded, also by overhead crane, into gondolas for shipment.

It was stated previously that the battery-powered trucks were "constantly and dependably moving about" inside the strip mill, and this was not a rhetorical statement. These trucks are operated about twenty out of the day's twenty-four hours, their only down time being for a change of battery, once every eight-hour shift, during the customary "lag" between shifts, and possibly when they are arbitrarily taken aside for examination once every day. Preventive maintenance looms large in the scheme of things in this mill. Spare batteries, one for every truck in operation, are provided so that a sufficient number are always on hand to provide for change-overs, or emergencies.

Despite the size of the batteries needed for these super-trucks, they are charged by a simple, inexpensive method, in a reasonable time. The power for charging is taken from the plant's power lines and converted to provide direct current, there being several types of battery charging generators in use.

For simple cost accounting, a reserve account is used for all charges in connection with powering the truck fleet. This account is accrued on a truck-hour basis. All charges for primary power metered to the battery chargers is cleared through the reserve account, as well as the labor charges and materials used for cleaning, flushing, and placing batteries on charge. As batteries come up for replacement, the cost of the new batteries is charged against the reserve account, and salvage received from scrap is credited to the account. While accruals have been 20 cents or less per truck hour for this "overall power cost," there has always been adequate reserve for the replacement of batteries and adequate funds to cover the charges for power and labor.

The "down-time" for a change of battery is liberally figured at 10 minutes per truck. The truck is positioned on a runway in the range of a small, floor-operated, overhead crane, by means of which the spent battery is removed and a freshly-charged one replaces it.

The eighteen battery-powered trucks at the Jones and Laughlin strip mill consist of fork and ram trucks of from 6000 to 10,000 lb; from 12,000 to 15,000 lb, and from 16,000 to 20,000 lb. There also is a battery-powered, articulated platform car-loader with a tilt device. This carries loads of 10,000 lb, and is loaded by fork trucks or cranes. Two battery-powered crane trucks, one of 10,000 pounds capacity at a 7-ft radius, the other of 20,000 lb capacity also are used in the mill.

—E-1—

LADLE DESIGN ELIMINATES TRUNNION SHAFT BENDING

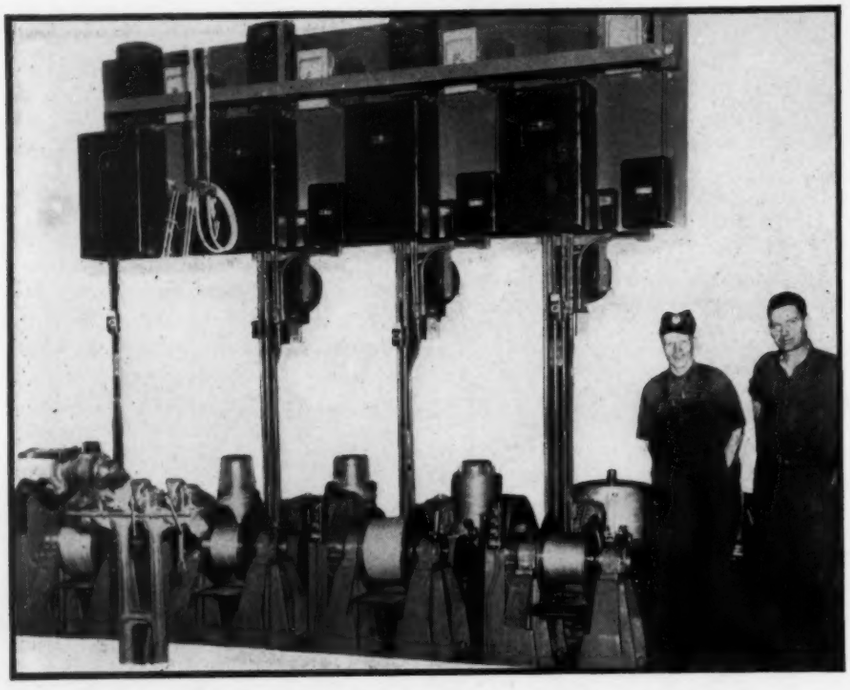
▲ A new line of advanced design, all welded, ladles has been introduced by Whiting Corporation. Harvey, Illinois. One of the outstanding features of these ladles are the trunnions which are welded to channel-shaped members permitting air circulation. This type of construction eliminates the distortion of trunnion shafts which, on the ordinary ladle, builds up month after month until binding action makes it difficult, and sometimes impossible to turn ladle to pouring position. To eliminate other pouring hazards, trunnion bearings, of the self-aligning anti-friction type, are enclosed in shot and dirt proof housing with shot guards provided for additional protection.

The tipping of these ladles has been facilitated by a new style gear bracket which, through self-locking gearing, eliminates backlash.

—E-2—

NEW ELECTRONIC WIRE WINDING UNITS TRIPLE PRODUCTION AT WIRE MILL

▲ Wire production at Jones and Laughlin Steel Corporation's wire rope division, Muncy, Pennsylvania, has been more than tripled per winding line since the mechanical equipment was redesigned and four 1-hp and four 2-hp General Electric "Thymo-trol" wire-winding units were installed. Taking 0.041-in. wire as the average, the eight new wire-winding lines and the remaining older lines now wind 80,000-125,000 lb, or well over 4000 miles of wire, in a 24-hr period.

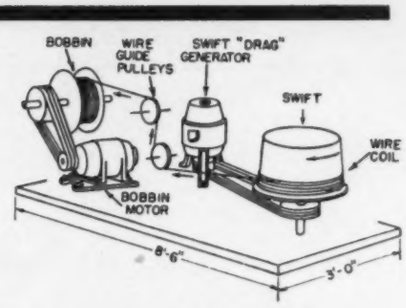


The new electronic equipment regulates the speed of the bobbin motor making it possible to hold wire speed constant.

Previously all wire at this plant had been wound on group-winding machines, each consisting of six winding bobbins and six unwinding swifts. The bobbins were driven by one constant-speed induction motor, through line shafts, gears, and individual disconnecting clutches, so that the wire speed increased as the wire continued to build up on the bobbin. The disadvantages of this arrangement were low average winding speeds, the difficulty of obtaining uniform winding tension, and high mechanical maintenance, since a breakdown on one machine put six lines out of order.

With the new equipment, the bobbin motor on each of four lines is rated 1 hp, 690/1380 rpm, 230 volts, d-c, while those on each of the four lines used for winding heavier wire are rated 2 hp, 1150/2300 rpm, 230 volts, d-c. The swift motor, which normally functions as a drag generator, is normally rated from one-fourth to one-third the rating of the bobbin motor. The wire leaves the swift at an almost constant unwinding radius. That is, the loose wire coil is thrown on the swift in such a manner that the inner wrap of the coil is "peeled" off the swift at the bottom inside "corner" of the swift core at a linear wire speed directly proportional to the swift rpm. The swift generator is loaded on an adjustable braking resistor. Thus, the swift generator controls wire tension and indicates wire speed.

The new electronic equipment regulates the speed of the bobbin motor, making it possible not only to operate at higher wire speeds than were formerly used, but to hold wire speed constant throughout the full bobbin build-up. The new controls are mounted directly above each of the lines, which are side by side and parallel to each other. This arrangement has effected a 50 per cent saving in floor space over the previous group drives. Another advantage of the new equipment is that wire is wound more tightly and uniformly, with more wire per bobbin and fewer breaks. Moreover, limit switches stop each line when the end of the wire leaves the swift and thus relieves operators for other duties. In addition, mechanical maintenance costs have been materially reduced.



On this new equipment wire is wound more tightly and uniformly with more wire per bobbin and fewer breaks.

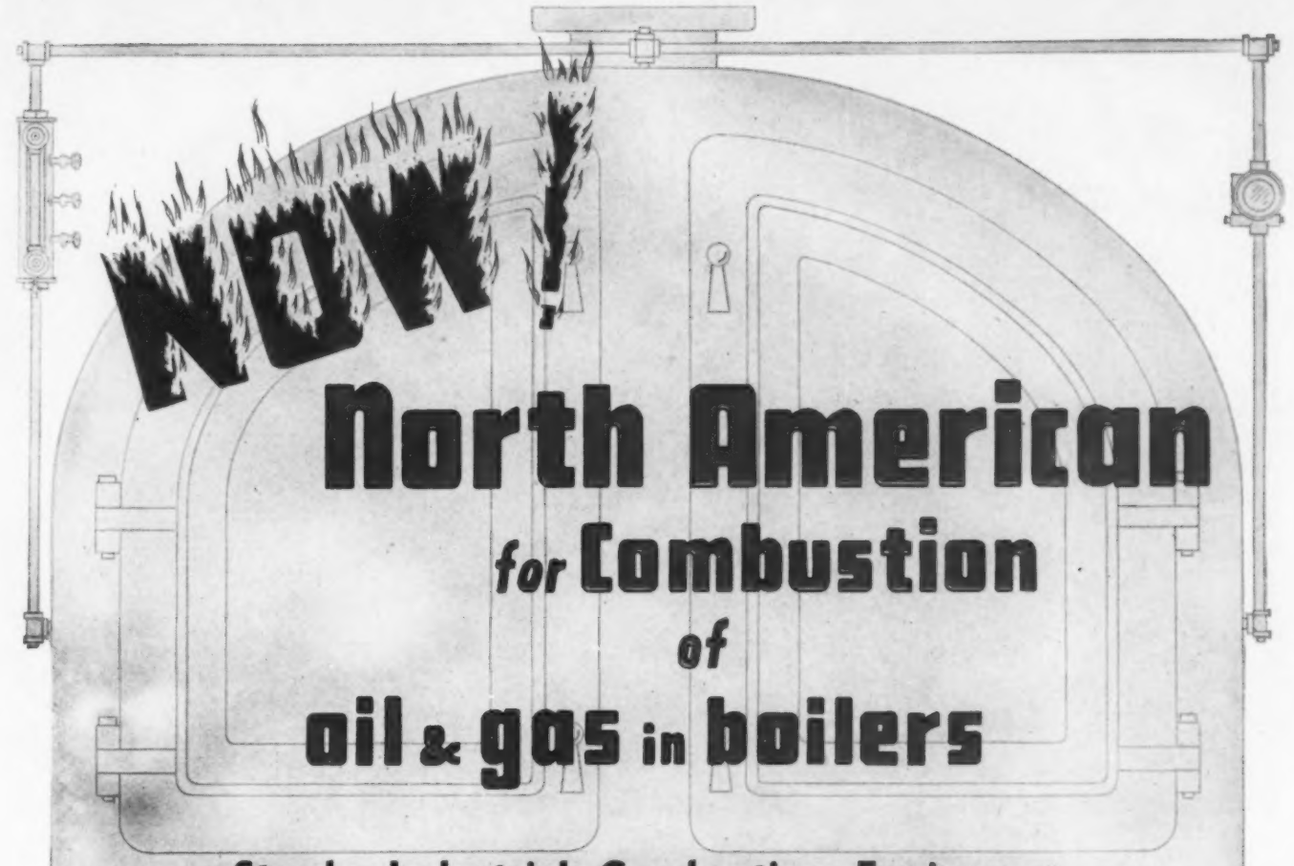
—E-3—

COATED ROD DEVELOPMENT SPEEDS WELDING OPERATION

▲ A new flux-coated bronze welding rod for application by the oxy-acetylene process has been developed by the Linde Air Products Company, unit of Union Carbide and Carbon Corporation, New York, New York, known as Oxweld No. 25M. When the rod is made, it is pre-coated with flux in proper proportion to its size. This coating consists of a flux plus a non-active binder that does not affect the weld. It adheres firmly to the rod, melting down into the molten puddle without burning off ahead of the rod. The rod can be heated and bent without destroying the coating. In addition, the coating is not affected by weather conditions.

This welding rod speeds up the welding operation and makes it easier to produce welds of uniformly high quality. The operator can give his entire attention to depositing the rod metal and controlling the molten puddle without the usual delays of dipping the end of the hot rod into the flux container. The flux melts into the weld continuously and in the right quantities, leaving no wasteful residue on the face of the weld. Thorough tinning, essential to good bronze-welding, continues without interruption.

—E-4—



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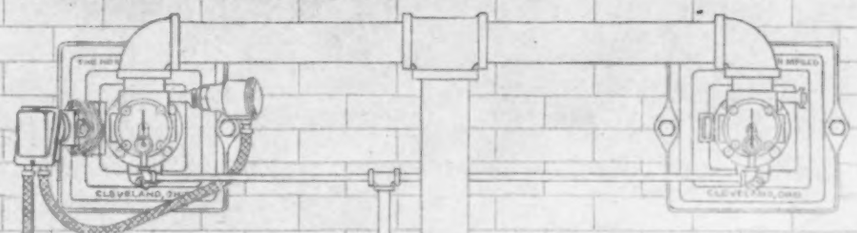
Multiple burners for volumetric turndowns as low as 1/25 — single burners for simplicity — exceptional fuel-air ratio fidelity over entire operating range — easy maintenance — complete safety.



THE NORTH AMERICAN MFG. CO.
CLEVELAND 4, OHIO
GAS OR OIL COMBUSTION EQUIPMENT
BRANCH OFFICES IN PRINCIPAL CITIES

THE NEW Fibron #5373 FLEXIBLE PLASTIC TUBING

Test Data

Tensile Strength.....3000 P.S.I.
Dielectric Strength (.020" wall) Wet.....1000 VPM
Dry.....1000 VPM
Life at 105° C.....2000 Hrs.
Chemical Resistance (room temperature)
50% Sulfuric Acid and
30% Sodium Hydroxide.....Unaffected
Does not support combustion
Low Temperature Flexibility
I.V.I. Pinch test.....—40°C.
Bell test.....—30°C.
Heat Endurance (.166" ID tubing, .016" wall) ASTM-D350-43T): 7 days @ 125°C.—No crack when bent 180° around ¼" mandrel—Retains flexibility when varnished and baked 22 hours at 260°F.—No flow or drip during 8 hours at 300°F.

This Irvington formulation provides new advantages, new cost-saving features, for many plastic tubing applications. For example: Transformer leads of #5373 remain flexible even after varnishing and baking . . . Underwriters' Laboratories approved #5373 insulation on applications involving continuous operating temperatures up to 75 deg. C. and intermittent temperatures as high as 85 deg. C. In addition, #5373 possesses the excellent electrical, mechanical and chemical properties which distinguish all Fibron tubings.

Tubings of Fibron #5373 are available in all standard colors and sizes, and in heavy wall thicknesses—in 36" lengths, continuous coils, or cut pieces. For full details and generous samples, write Dept. 60, Irvington Varnish and Insulator Co., Irvington 11, New Jersey.

IRVINGTON *Varnish and Insulator Company*
IRVINGTON 11, NEW JERSEY, U.S.A.

NEW SCHOLARSHIP FUND FOR ARMCO EMPLOYEE OFFSPRING

▲ Details of operation of a scholarship fund to send children of employees of the American Rolling Mill Company in any of its plants to the University of Cincinnati for engineering cooperative courses were recently announced.

Chief executives of Armco have personally created a fund of $1500 to finance two scholarships annually. This will be known as the George M. Verity educational opportunity fund in honor of the firm's founder, long a personal friend and admirer of the late Dean Herman Schneider, originator of the Cincinnati co-operative plan of technological education. Dr. Schneider died in 1939 and Mr. Verity in 1942.

Two scholarship winners will be selected to begin their university studies next fall. Winners will be eligible for co-operative employment in Armco plants. The plan provides for alternating periods of study in classroom and laboratory and of "on-the-job" work in industry, combining theory with practice.

RUSTPROOFING PROCESS FOR PRIMARY STEEL PRODUCERS

▲ A new low-cost rustproofing technique for steel and galvanized steel, known as the "Banox" process, which not only will protect metal during the manufacturing stages but permit a tighter bond with paints, and give it longer life through greatly enhanced corrosion resistant, has just been announced by Calgon, Inc., Pittsburgh, Pennsylvania.

The basis of this new chemical process is a flexible, glassy metal phosphate coating, so plastic that it will bend with the steel or permit diestamping without harm to the coating. The coating, which has a thickness of from 5 to 15 millionths of an inch, may be put on by the spray, immersion, or brush methods. It requires no heat.

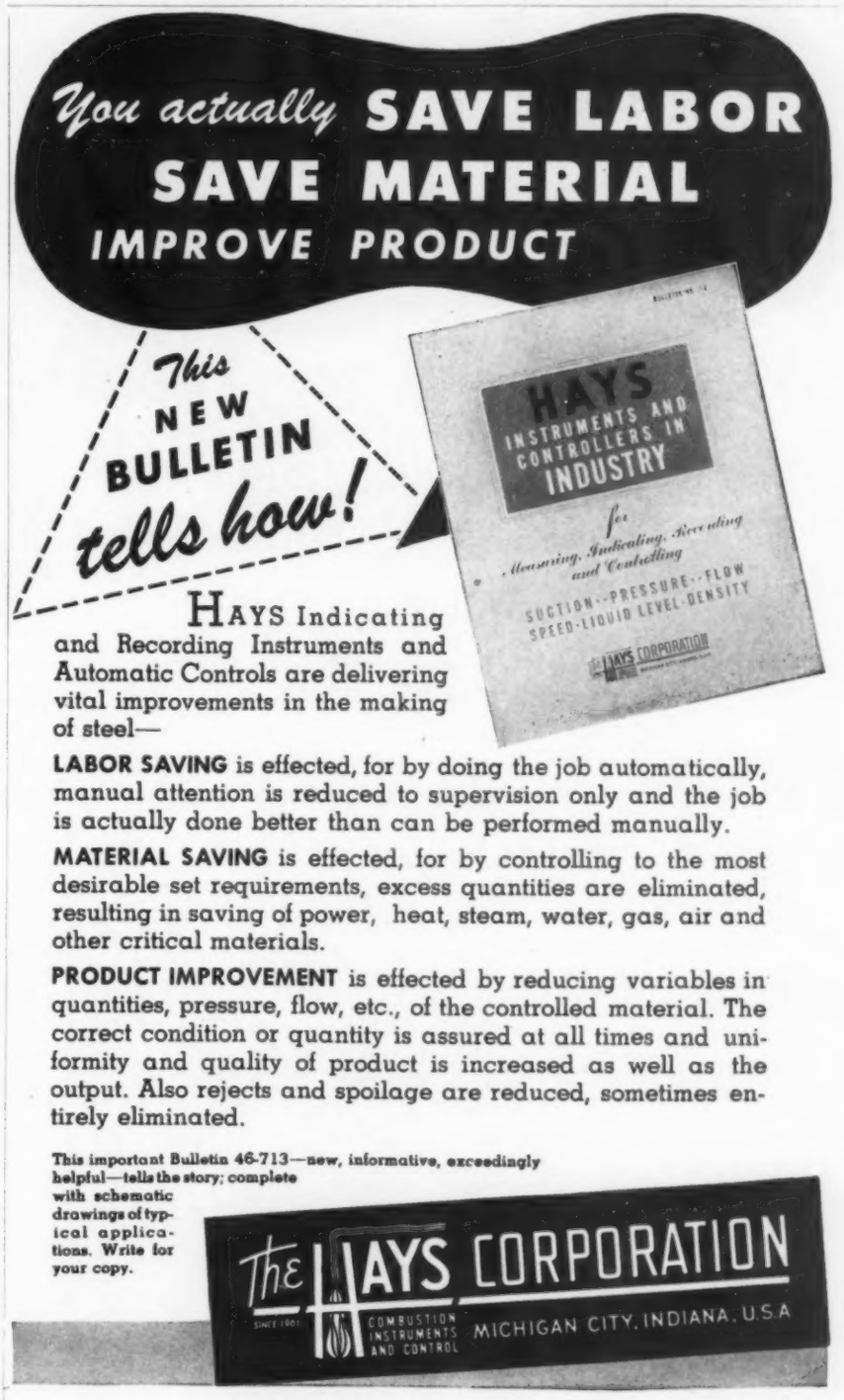
Many branches of the steel business will find it of interest. The process can be used by the primary steel manufacturing plant, by the converter, and by the final fabricator of consumer goods.

Considerable latitude in the coating time may be had by altering the working concentration. This process is operated at normal temperature and requires no heat. Good coatings have been produced in actual practice in as short a time as 10 seconds at 80 F.

The treatment of steel by this process is said to accomplish four purposes:

1. Prevent rusting between cleaning and painting.
2. Insure a grease-free and alkali-free surface, providing for maximum adherence and flexibility of organic finishes.
3. Greatly increase the durability of the finish as measured by outdoor exposure, salt-spray, "sweat-box" humidity, and water immersion tests.
4. Prevent spread of rust from unprotected edges, scratches and other areas where the basic metal is exposed.

—E-5—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HAYS INSTRUMENTS AND CONTROLLERS IN INDUSTRY
for Measuring, Indicating, Recording and Controlling
SUCTION--PRESSURE--FLOW
SPEED-LIQUID LEVEL-DENSITY
HAYS CORPORATION
HAYS Indicating and Recording Instruments and Automatic Controls are delivering vital improvements in the making of steel—
LABOR SAVING is effected, for by doing the job automatically, manual attention is reduced to supervision only and the job is actually done better than can be performed manually.
MATERIAL SAVING is effected, for by controlling to the most desirable set requirements, excess quantities are eliminated, resulting in saving of power, heat, steam, water, gas, air and other critical materials.
PRODUCT IMPROVEMENT is effected by reducing variables in quantities, pressure, flow, etc., of the controlled material. The correct condition or quantity is assured at all times and uniformity and quality of product is increased as well as the output. Also rejects and spoilage are reduced, sometimes entirely eliminated.
This important Bulletin 46-713—new, informative, exceedingly helpful—tells the story; complete with schematic drawings of typical applications. Write for your copy.
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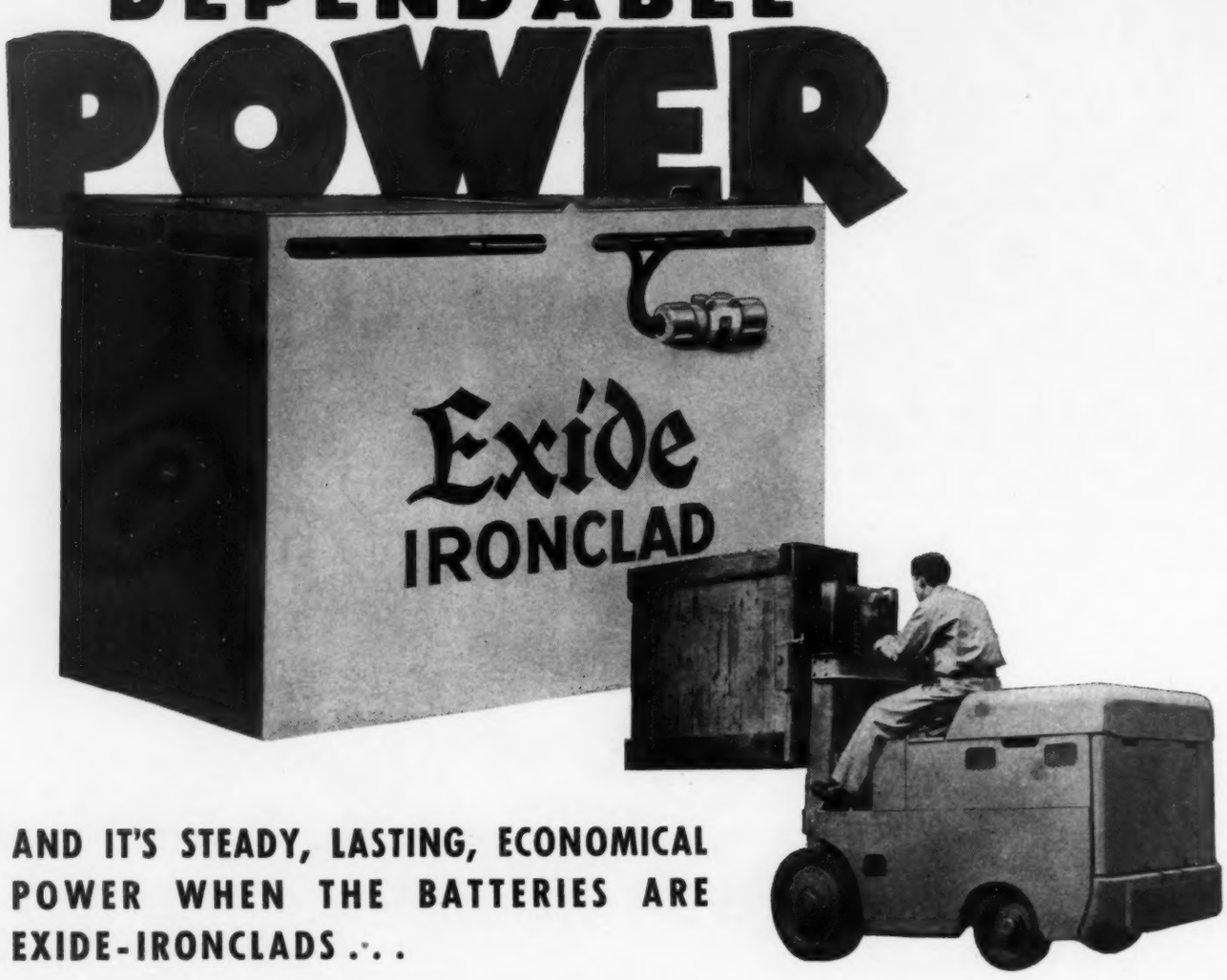
DEPENDABLE POWER



AND IT'S STEADY, LASTING, ECONOMICAL POWER WHEN THE BATTERIES ARE EXIDE-IRONCLADS . . .

More and more, management executives are finding that Electric Industrial Trucks, powered by Exide-Ironclads, are the *right answer* to their materials handling problem. Numerous records prove that this efficient combination assures more tons per man per hour . . . and at lower cost, which means greater profits.

Exide-Ironclad Batteries deliver continuous service day in and day out for years. They have the *high power ability* required for frequent "stop and go" service . . . the *high maintained* voltage that constant lifting, hauling and stacking demands . . . and the *high capacity* needed to assure steady, day-long performance with full shift availability.

Write us for a FREE copy of Exide-Ironclad Topics which contains "Case Studies" of materials handling problems. It tells how to cut handling costs up to 50% . . . covers latest developments in handling materials from receiving to shipping.

Materials Handling offers one of the greatest opportunities for reducing costs and increasing profits, that are available to Management today.

ELECTRIC INDUSTRIAL TRUCKS POWERED BY EXIDE-IRONCLADS HAVE ALL THESE FEATURES . . .

- Inherently dependable
- Built for long, hard service
- Provide maximum safety . . . best working conditions
- Fast handling and accurate spotting
- Effective use of lowest cost power
- Lowest overall cost

HIGHEST EARNINGS
GREATEST SAVINGS

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia 32 • Exide Batteries of Canada, Limited, Toronto

STEEL INDUSTRY WILL SPEND $327,000,000 ON EQUIPMENT

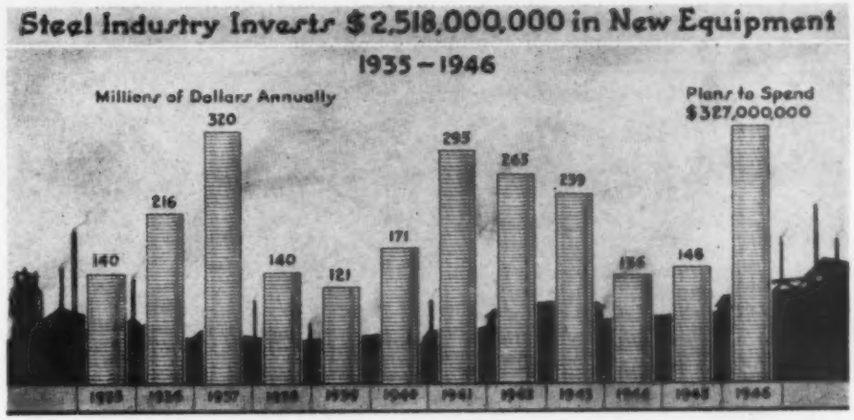
▲ Steel companies are planning to spend this year the record-breaking total of $327,000,000 for new equipment and additional facilities needed to fill postwar steel demands.

The industry's anticipated expenditure for new equipment in 1946 raises to $2,500,000,000 the total amount of money spent since 1935 by steel companies to expand and improve their plants. Half of that total was spent between 1940 and 1945 as the industry's share of the wartime expansion program. The other half, spent in peacetime years, represents the cost of the industry's continuous program of improving its extensive facilities for producing steel.

Anticipated new equipment expenditures for 1946 exceed by 10 per cent the peak reached in any year of the war and are more than double the amount actually spent in 1945.

At the beginning of 1945, steel companies estimated that during that year they would spend about $200,000,000 of their own funds to wind up the wartime program of plant expansion. The end of the war, however, made unnecessary the spending of the full amount. Actual expenditures during 1945 totaled $148,000,000.

Most of the expenditures scheduled for 1946 will be for new and improved rolling mills and finishing facilities. Because of the huge wartime expansion in blast furnace and steelmaking facilities, relatively little new construction is anticipated in those departments during the current year. Instead, the bulk of the expenditures will go to buy new machinery and equipment for producing highly finished types of steel for civilian goods.



Included in the expenditures for 1946 are the costs of several continuous mills for producing cold rolled sheet and strip steel, used for automobiles, refrigerators, ranges, etc.

NEW MECHANICAL PICKLER ACCELERATES OPERATION

▲ Pickling of steel bars can be greatly accelerated by the practice of raising and lowering a sling full of bars in the pickle vat. This procedure causes the bars to move one against the other, cracking the oxide scale and aiding in its removal. Utilizing this principle, The Youngstown Welding and Engineering Company, Youngstown, Ohio, has developed a new mechanical pickler which automatically raises and lowers five to ten tons of bars at a predetermined, continuous rate. Ordinarily, this work is done by a crane, and the new pickler thus releases the generally overworked crane for other plant operations. Pickling time is often cut 40 to 60 per cent, with resultant savings in steam, man power, and maintenance.

Operation of the mechanical pickler is simple. Two horizontal shafts at each side of the pickling tank are geared to a driving mechanism. Sheaves, fixed to the shafts, carry the chains. When the pickler is operating, the chains move; this causes rod bars and other stock being pickled to revolve against each other in the solution. In this way, all surfaces are exposed to action of the solution, and scale removal is speeded by the rubbing action. When used for tubing, the pickler raises the tubes out of the solution and tilts them. Thus, the tubes are flushed out, providing a more vigorous pickling action on the inside surfaces of the tubes. The cycle of raising and lowering the shapes into the pickling solution can be regulated by simple adjustment, according to the requirements of the material being processed.

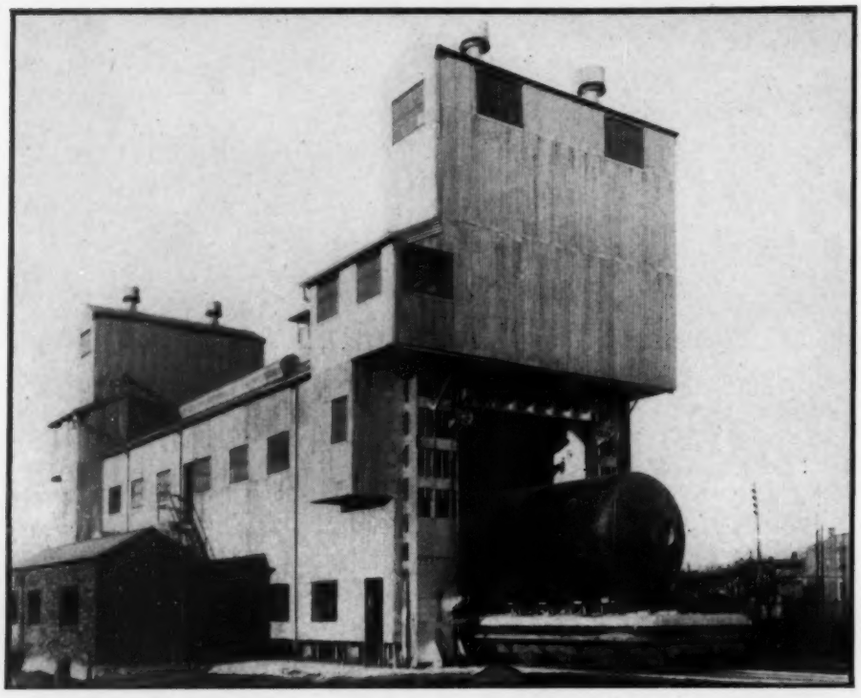
The advantages of mechanical picklers are generally known, and there are several types in operation throughout industry. However, the new pickler has several features not found in other designs. There is a minimum amount of chain used, hence replacement and repair costs for this item are kept low. In many cases, the pickler will do the work of two or three ordinary still pickling tanks, resulting in further savings. In addition, the pickler will handle a wide variety of shapes — bars, rounds, flats, squares, hexagons, and tubing. Another outstanding feature is its simplicity of operation and control. Chains and other exposed parts are made of alloy metals to provide strength for heavy loads, resistance to the severely corrosive action of the hot acid pickling solution, and resistance to wear.

Although the design of this pickler has been standardized, it is possible to fit this equipment into any type plant. It can be built to any capacity.

This new mechanical pickler automatically raises and lowers five to ten tons of bars at a predetermined, continuous rate.

—E-6—

COMPLETE STRESS RELIEVING FURNACE



One of the first charges entering the recently completed stress relieving furnace of Chicago Bridge and Iron Company at Chicago, Illinois. This is the largest of three furnaces constructed by Rust Furnace Company, Pittsburgh, Pennsylvania, for Chicago Bridge and Iron Company, being 85 ft long, by 15 ft 2 in. wide, by 16 ft high from car floor to spring of arch. It has a car width of 11 ft. The roof is sprung. Another furnace for stress relieving welded vessels is being erected at the company's Greenville, Pennsylvania, plant, while a third primarily for heating of heavy plates and for alloy heat treating is being erected at the company's Birmingham, Alabama, plant. All will be completed in 1946.

—E-16—

WEIRTON STEEL BUILDS MODERN OXYGEN PLANT

▲ A new oxygen plant having a total capacity of 150,000 cu ft per day or about 4,500,000 cu ft per month has been built at Weirton Steel Company, Weirton, West Virginia. The new plant was built in the former shell plant. Oxygen is made in the new oxygen plant by separating the oxygen from the nitrogen in atmospheric air. The plant was furnished by Air Products, Inc., Chattanooga, Tennessee.

The sequence of operations is briefly as follows: Atmospheric air is drawn from the outside through a filter into a three-high stage compressor. The air is compressed in the first stage to 50 pounds pressure after which it is cooled and passed through two caustic soda towers for removal of carbon dioxide. It then returns to the compressor where it is compressed to 200 pounds and finally to 750 pounds in the last stage. This 750 pound air is cooled to room temperature and then passed through an aluminum oxide drier which removes the moisture in the air to a dew point of minus 200 degrees F. The air then passes through coolers where it is cooled by the nitrogen and oxygen being made in the plant proper. The air is cooled to a temperature of about minus 230 degree F and is still at a pressure of about 700 pounds. The air then passes through an expansion valve and pressure is dropped to 65 pounds and its temperature drops to about minus 300 degrees F at which point the air changes into a liquid. This liquid air is then distilled in two stages of distillation so that the nitrogen boils off from the liquid air the same as steam boils off water. After the nitrogen all boils off, liquid oxygen remains. The liquid oxygen is pumped from the distillation column, passes through the heat exchanges previously mentioned and is vaporized by the temperature of the incoming compressed air. The oxygen is then in the gaseous form and ready for pumping into cylinders for storage or for filling cylinders for use around the plant.

In the oxygen plant there are three banks of cylinders which are used for the storage of oxygen to take the ups and downs in oxygen consumption. These contain approximately 800 cylinders with 200,000 cu ft capacity of oxygen. As the demands for oxygen go up and down, these cylinders are emptied or filled according to requirements. The cylinders in this storage bank feed a pipe line system which extends through the steel works in the blooming mill, welding shop, open hearth and stock house departments and which is in process of being extended to the blast furnace boiler house, strip steel and 48 in. mill departments. When these pipe lines are extended, the handling of cylinders will be greatly reduced. The oxygen is delivered through the pipe lines at about 150 pounds pressure. The oxygen that is delivered in cylinders is at 2200 pounds pressure.

The oxygen plant which started in operation January 1 of this year is the most modern type of oxygen generating equipment. Weirton is the first steel mill in the country to install this type of equipment which was developed during the war for our armed forces and became available for industry after the end of hostilities.

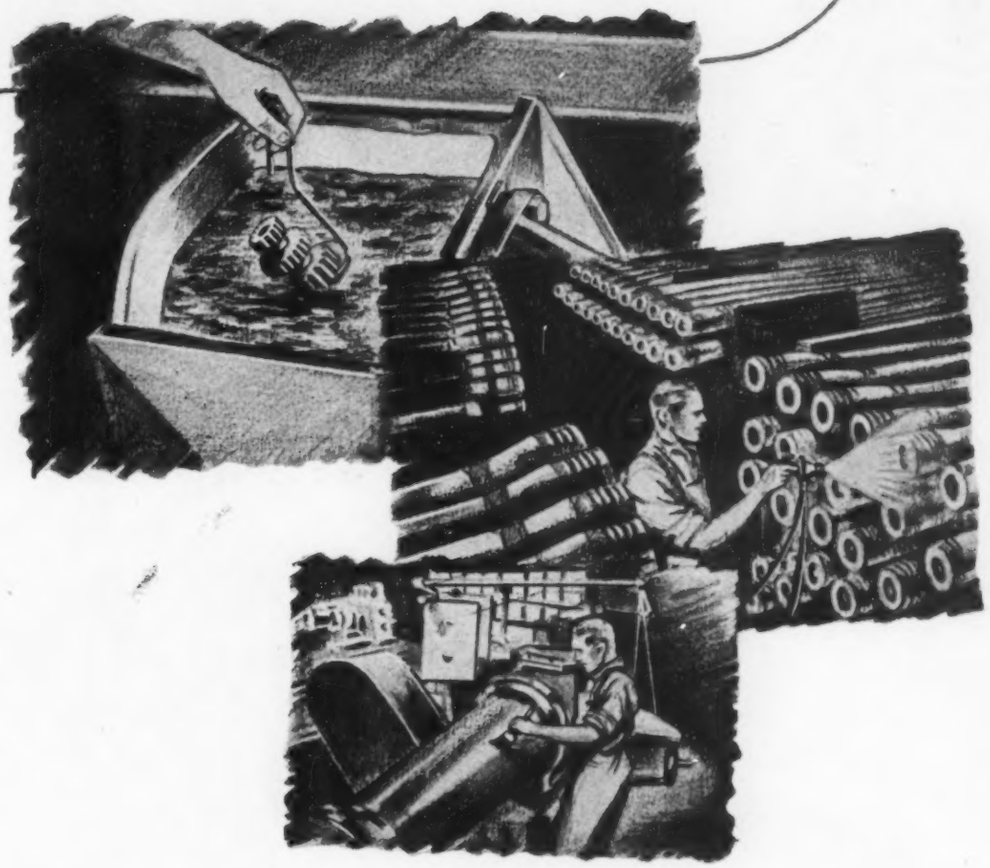
—E-7—

STAINLESS STEEL TUBING PATENTS ARE AVAILABLE

▲ The alien property custodian recently announced that fourteen U. S. patents on the manufacture of stainless steel tubes which were seized from enemy nationals are available for licensing to American citizens. Several of these patents disclosed new designs and devices which appear to be practical for use in this country. He added that the inventions are the result of work of enemy technicians in the Dusseldorf area, the heart of the German steel industry.

Licenses are available on a royalty-free, non-exclusive basis for the remaining life of the patent. An administrative fee of $15.00 is charged for each patent licensed. A list of the patents and complete licensing information may be obtained from the Patent Use and Development Section, Office of Alien Property Custodian, Washington 25, D. C.

Rust Protection for all metal surfaces WITH Tycol NO-RUST-OLS



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CAST STEEL VALVES FOR HIGH PRESSURES

▲ American Car and Foundry Company announces they will extend their production of lubricated plug valves to include cast steel valves in series 100 and 300 in sizes ½ in. to 8 in. These cast steel lubricated plug valves will be particularly adapted for high pressures and temperatures where required and in addition the cast steel necessarily offers greater abrasion resistance and, on some services, greater corrosion resistance.

The new applications for these cast steel valves include high pressures in oil field production work, process plant application, refining installations where external fire hazard prevails, and on any service where cast steel valves are indicated as contrasted with a semi-steel, cast iron, or bronze valve.

—E-8—

SIMPLIFIED PRACTICE FOR CARBON STEEL PLATE

▲ A voluntary simplified practice recommendation for thicknesses for carbon steel plates, as proposed by the technical committee on carbon steel plate and structural shapes, of the American Iron and Steel Institute, has been submitted to producers, distributors, and users, for their comment or approval, or both, according to an announcement of the division of simplified practice, of the National Bureau of Standards.

According to the recommendation, thickness may be specified in either of two ways: by measurement in inches, which range from 3/16 inch to 2 inches, inclusive; or by weight per square foot, commencing with 7.65 pounds and ending with 81.60 pounds. Plates over 2 inches to 6 inches thick progress in increments of ⅛ inches. Those over 6 inches thick advance in quarter inches.

Early in the war it became imperative to simplify plate thicknesses in order to meet production goals, and a very large proportion of the record production actually achieved was based on such simplification. It is desirable to utilize this experience, through the establishment of a simplified practice recommendation embodying a simplified list, adjusted to suit normal conditions.

Among the advantages to be derived from general adherence to the recommendation are: continuation of reduced number of thicknesses; more efficient mill operation; expeditious delivery; reduction in inventories; improved service to users; and more economical manufacture.

For the reason that as many firms as possible should be given an opportunity to examine the proposed recommendation, readers of this announcement are invited to make known their interest by writing to the division of simplified practice, National Bureau of Standards, Washington 25, D. C.

USSR CONSTRUCTING STEEL TUBE MILL

▲ The great new tube rolling mill, now in construction at Sumgait, on the Caspian Sea, will when completed supply the needs of the oilfields of Baku, Grozny, and the Emba. It will turn out 40 per cent of the previous Soviet production of all types of tubing. The idea of the project is to be able to supply all the tubing needs of the oilfields in the Caucasian area.

Sumgait, which is in the Soviet Republic of Azerbaidjan, was quite a small place before this big construction plan was contemplated, but it is now to become a substantial town and modern in every respect. All stages of production, from steel making to the finished product will be accomplished on the spot. The plant will be the most modern of its type, equipped to turn out high-quality tubing. Production will be organized so that all processes, from the heat treatment of metal to stacking the finished products will be connected mechanically.

The construction of the works has begun with the erection of auxiliary departments, machine shops, foun-

(*Please turn to page 109*)

I DESIRE MORE INFORMATION IN DETAIL ON THE ITEMS BELOW:

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Insert numbers below corresponding to those of the *News Supplement* items in which you are interested in receiving detailed data.

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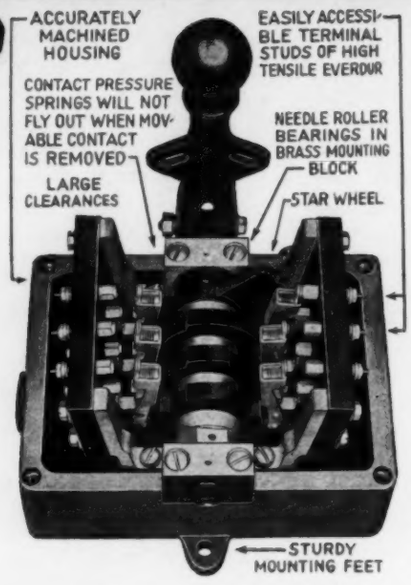
"3C" MASTER SWITCHES for FREQUENT OPERATION on MILL and CRANE, and OTHER HEAVY DUTY PILOT DEVICE APPLICATIONS

Type RD3-6, Enclosed View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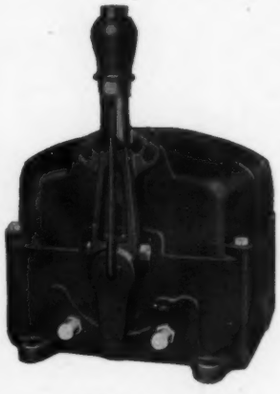
EASILY ACCESSIBLE TERMINAL STUDS OF HIGH TENSILE EVERDUR
CONTACT PRESSURE SPRINGS WILL NOT FLY OUT WHEN MOVABLE CONTACT IS REMOVED
NEEDLE ROLLER BEARINGS IN BRASS MOUNTING BLOCK
LARGE CLEARANCES
STAR WHEEL
STURDY MOUNTING FEET

Type RD3-6 with Cover Removed

Type RD Reversing Master Switch with Mechanical "OFF" Point Latch

Master Switch, Enclosed Type S2D, 2 Circuit



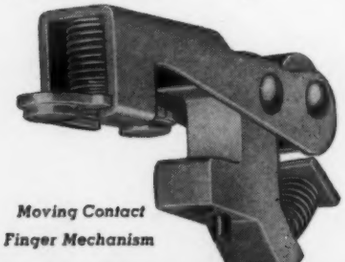
Type RD Reversing Master Switch with Electrical Handle Switch

THOUSANDS of sturdy, reliable "3C" Bulletin 101 Master Switches are operating in all types of industries. Built for "rough and tumble" use in frequent operation, a minimum of maintenance is made easy by complete accessibility. And those contact pressure springs on the double break silver to silver alloy contact fingers can't fly out! No hunting in dark corners for elusive springs! Cams are accurately molded of high impact bakelite. Needle Roller Bearings on Type RD—Oilite Bearings on Type SD. Up to 6 points in each direction and 18 circuits available on Type RD, up to 2 points in each direction and 4 circuits available on Type SD. Spring return available in both types.

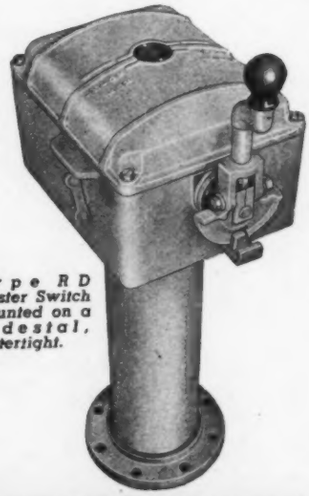
Ask for Bulletins 101 FS and RD.

The moving contact finger mechanism pictured below fits both types, and by removing one screw the entire assembly is easily lifted out.

Master Switch, Enclosed Type S4D, 4 Circuit



Moving Contact Finger Mechanism



Type RD Master Switch Mounted on a Pedestal, watertight.

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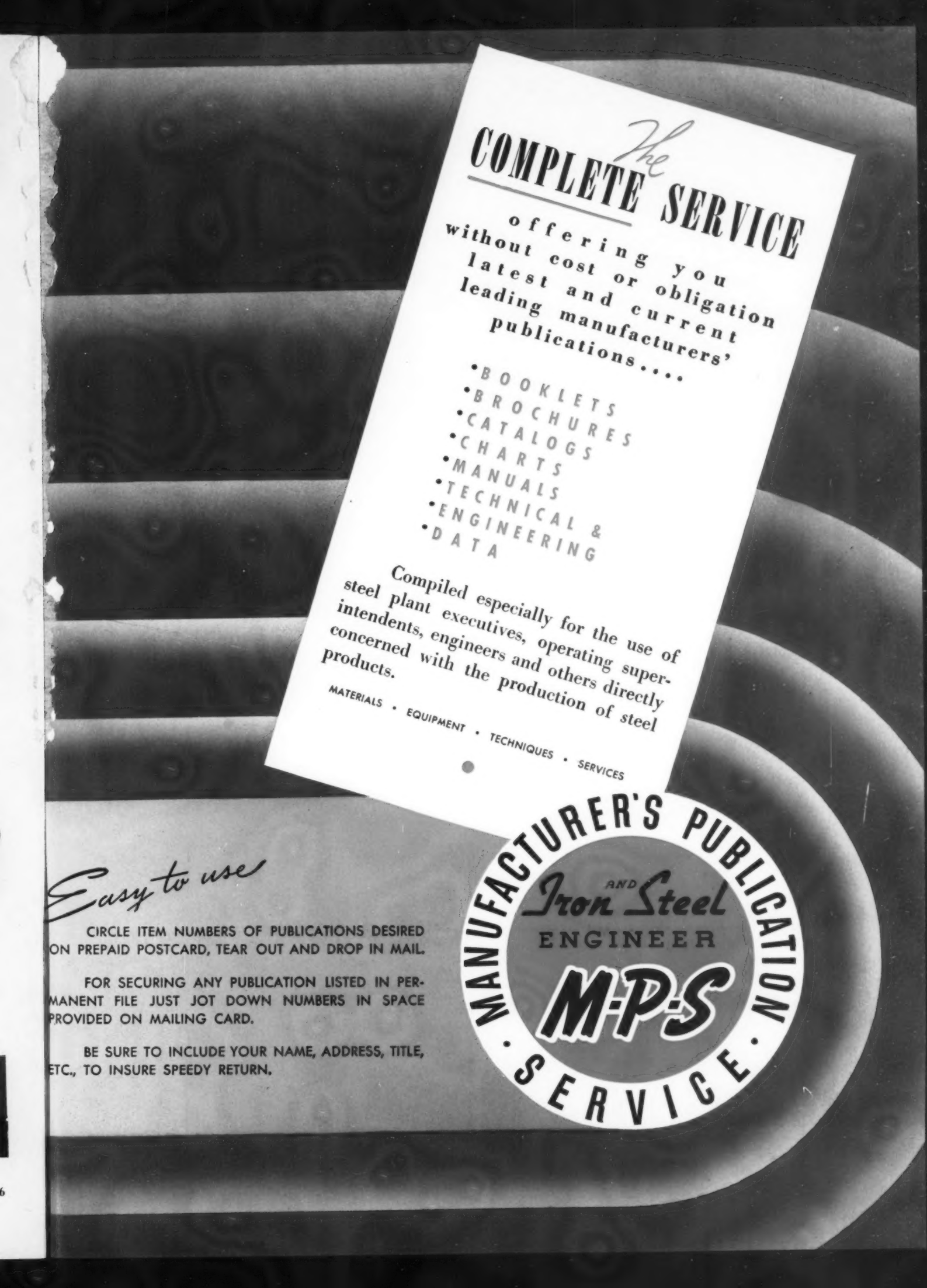
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FOR THOSE WHO MUST *KNOW* . . .

(1) Engineered Heat

If the heating of metal is required in your work, you will get a lot of good ideas from a new booklet on "Engineered Heat." Designed for engineers and production men, this booklet contains descriptive information on circular soaking pits, various types of heating furnaces, and auxiliary equipment. Included are a number of installation pictures and easy-to-use tables and charts on temperature conversion and thermal efficiency of fuels. (16 pages). Salem Engineering Company.

(2) Testing Machines

Included in an amply illustrated new catalog is a complete description of the principle and operation of the pendulum lever weighing system, hydraulic and electro-mechanical loading systems, testing ranges, and specification details on machines in ranges from 1000 to 1,000,000 or more pounds. The purpose of this booklet is to give you a comprehensive digest of the principles, construction, and operation of modern testing machines. (30, 60 pages). Tinius Olsen Testing Machine Company.

(3) Clamshell Buckets

Four-rope clamshell buckets are the subject of a new bulletin just issued. The buckets described are designed for handling coal, iron ore, open hearth slag, and most granular, free-flowing materials. Line drawings not only show various types of buckets, but also the manner in which they are geared and reeved. These buckets are used primarily on bridge cranes, with man trolleys, and with fleet through sheave type trolleys, also on unloading towers and on boom type and overhead cranes. (2059, 44 pages). Blaw-Knox Division of Blaw-Knox Company.

(4) Feed-Water Control

A new booklet is available to you on the first controlled-forced-circulation boiler installed in America, the unit at the Montaup Electric Company's Somerset Station, Fall River, Massachusetts. This is one of the most important steam generating units placed in service during the 1940's. This unit was the first to operate at higher steam pressure and temperature than had been attained in any previous installation. (447, 20 pages). Northern Equipment Company.

(5) Watt-Demand Meter

A new thermal watt-demand meter, operating on the "direct heat" principle and known as "Type HI-1" is announced in a new bulletin. The "direct heat" principle is based on the use of temperature-sensitive, bi-metallic spirals that act as their own heaters, thus increasing the life and accuracy of the meter while minimizing the need for maintenance. (GEA 4541). General Electric Company.

(6) Water Cooled Door

A bulletin is available on a new water cooled door for open hearth and heating furnaces. The new door, manufactured for all open hearth and furnace sizes, has water cooled ribs dividing the plastic refractory into easily cooled sections, which not only add strength to the door but also eliminate warpage, insuring a longer life for both the door and the lining. William M. Bailey Company.

(7) Electronics Guide

A new guide to electronics has just been published to show how electronics is already speeding production, saving time and materials, and promoting safety in industrial plants, and to suggest how you can put electronics to work. The guide explains the six fundamental functions of electronic tubes, rectifying, amplifying, generating, controlling, counting and sorting, inspecting; and describes the tubes required for each function. (A-4726, 28 pages). Westinghouse Electric Corporation.

(8) Valve Reference Book

A reference book on valves is available to you which includes a description of quarter-turn valves. These quarter-turn valves are said to insure instant action because a quarter-turn fully opens or closes these valves. They operate 16 to 28 times faster than screw-stem types. A positive fluid control is guaranteed because cam presses seating surfaces firmly together in closed position, yet valve operates freely. Sealed bottom, bonnet and stem, prevent wasteful, outside leakage. (38). Homestead Valve Manufacturing Company.

(9) Spray Nozzles

A catalog describing spray nozzles designed to accommodate high working pressures through longer periods of time. Continuous high-pressure work such as the cooling operation in modern rolling mills quickly wears out ordinary nozzles. This spray nozzle is built in one piece for long, tough service. There is nothing to wear loose. It is made to order for the demands of steel mill service. (459). Chain Belt Company.

(10) High Temperature Pickling

A technical bulletin which tells the ways to step-up production with high temperature pickling, continuous or batch, is available to you if you circle number ten below. The description of the step-up method tells how production was boosted in one plant from 250 to 540 tons in eight hour periods. (TV-7B). Atlas Mineral Products Company.

(11) Rubber Insulation Available

A complete story on the return of natural rubber insulation for cables is contained in a new research bulletin available to steel mill operators and engineers. The use of natural rubber has been authorized for those severe service conditions where wires and cables are to be installed in wet locations. This insulation made with wild "Up-River Fine Para" rubber applied to the conductor by the strip insulating method and vulcanized in a continuous metal mold is once again available to industry. (101). Okonite Company.

(12) Electrical Controls

A condensed general catalog which is issued periodically is available to you. The catalog contains descriptions, sizes, illustrations, and prices of electrical control apparatus such as: enclosed safety switches; industrial circuit breakers; multi-breaker load centers, manual and magnetic motor starters; panelboards; switchboards; bus bar systems; and open knife switches. All electrical shop and maintenance men should have this publication. (Trumbullist). Trumbull Electrical Manufacturing Company.

(13) Indicating Dynamometer

A file folder is available on a new remote indicating dynamometer known as a "Tens-o-Trol." This is a brand new type of tension or weight measuring instrument that has application throughout all industries. In many types of weight measuring or tension indicating it is not possible for the operator to be close enough to the measuring instrument to read it. With the new "Tens-o-Trol" this difficulty has been completely overcome by the use of remote repeater stations that may be as far as 300 feet from the actual measuring dynamometer. W. C. Dillon and Company, Inc.

(14) Cutting Fluids

A pocket-sized publication on "Water-Mixed Cutting Fluids" containing a wealth of practical information for users of so-called soluble oils has recently been published. Among the featured articles are "Cutting Fluids and Hygiene" and "Design Data for Cutting Fluid Systems" with accompanying charts. (20 pages). D. A. Stuart Oil Company.

(15) Materials Handling

Recently released is a booklet covering handling and processing equipment for all industries — includes electric vibrating feeders, crushers, pulverizers, screens, dryers, coolers, magnetic separators, bucket elevators, chains, and control equipment. (791). Jeffrey Manufacturing Company.

(16) Recording Instruments

Just issued is a catalog presenting a full line of recording and indicating instruments for measurement and control. Arranged for quick reference, and profusely illustrated, the sections deal with instruments for temperature applications, pressure, humidity, flow, liquid level, density, and other process variables. Control valves, planimeters, instrument accessories and supplies are included. (370). Foxboro Company.

(17) Bearing Handbook

A huge catalog packed with details is available by circling number seventeen below. Bearing sizes and load rating tables, together with a bearing type index, facilitate bearing selection based on ratings given for standard motor speeds. New bearing application drawings and sources for bearing mounting parts are shown, together with a section devoted to bearing care and lubrication. (F-1000, 184 pages). Norma-Hoffmann Bearings Corporation.

(18) Variable Speeds

Said to be the most comprehensive book on variable speed control ever published is a new condensed catalog just printed. It shows how variable speed control can be applied to all types of production machines to step-up output and improve processing. The catalog shows the newest designs of modern speed control equipment, including an hydraulic automatic control, and the reducer type transmission, which provides speed variation and gear reduction in one compact unit. (G-450, 96 pages). Reeves Pulley Company.

(19) Speed Transmissions

An engineering data catalog covering a positive infinitely variable all-metal chain

gear that gets any desired speed instantly while the machine is operating and maintains it accurately — using a "unique chain that automatically makes its own teeth." No belts are used. The book includes complete engineering data on making a specific application. (1874, 56 pages). Link-Belt Company.

(20) Steam Turbines

Bulletins are ready for you in looseleaf form covering a complete description of solid wheel turbines with cross section drawings of typical units for both moderate and high steam pressure conditions. Included is a description of the axial flow impulse, both single stage and multi-stage. Terry Steam Turbine Company.

(21) Engineering Manual

An engineering manual which gives a comprehensive review of the principles affecting the selection, application and operation of anti-friction bearings is yours by circling proper number and mailing the postcard below. Of special interest is a complete resume of the engineering fundamentals involved in correlating design requirements, load characteristics and service conditions to the choice of the particular size and type of bearing. (200 pages). Fafnir Bearing Company.

(22) Hydraulic Handbook

A new edition of an hydraulic handbook is now ready for steel mill engineers interested in pumps and hydraulic equipment. It contains complete, authoritative hydraulic information and tables. Included is a resume of this company's manufacturing facilities and a condensed catalog of their products. (50). Aldrich Pump Company.

(23) Industrial Exhausters

Available to you is a bulletin on industrial exhausters. Industrial exhauster service is the most exacting on which fans are used. This industrial exhauster was designed from the accumulated experience of 68 years of fan-building. Sturdy, efficient and practical in design, it is also flexible in application. (3576). Buffalo Forge Company.

(24) Electrode Properties

Facts you should know about electrodes are covered in a new catalog available to you. Compiled by leading technicians in the field, this definitive work gives authentic, understandable information on electrodes. It includes information on application, welding procedure, mechanical properties and specifications. Every steel mill man will find almost daily use for this helpful manual. (120). Air Reduction Company.

(25) Panelboards

A condulet catalog is available to you covering panelboards, distribution centers, circuit breakers, and other electrical fittings. The various sizes available with advantages of each are included in a complete listing. (2500). Crouse-Hinds Company.

(26) Control Instruments

A new bulletin describing a line of pH control instruments has just been announced. These pH controllers and recorders are described in detail including electrode assemblies and accessories. The bulletin includes engineering and technical information relative to pH theory and measurement. A variety of actual installations are described with chart records, photographs, and flow diagrams included. (1302). Bristol Company.

(27) Switchboards and Switchgear

Described in a new large catalog is a complete line of switchboards, panelboards, switchgear, fuses, lugs and other accessories. Contains wiring diagrams motor circuit data, properties of conductors and other handbook data for electrical men. (170 pages). Pelham Electric Manufacturing Corporation.

(28) Semi-Finished Steel Rolling

We have in stock a few reprints of an excellent article entitled: "The Rolling of Semi-Finished Steel" written by a prominent superintendent, roll shops. This paper briefly outlines the methods and problems in rolling semi-finished steel, and describes some of the mills used for making these products. Included is a brief discussion of roll design. If you circle number 28 below, we will send you a copy.

(29) Insulating Firebrick

A bulletin is available giving data on the performance of insulating firebrick. These firebricks store and conduct less heat than heavier insulating firebrick and consequently afford faster heating-up time. This means that less fuel is required to bring the furnace to operating temperature, with savings in overall operating costs. (R-2-G, 20 pages). Babcock and Wilcox Company.

(30) Electric Welding

A bi-monthly publication on welding news is available to you if you are a production minded welding man. It is distributed free of charge and contains interesting articles on the latest practices in the resistance welding field, and illustrates machines of unique design. The company manufactures manual, air, hydraulic, motor-driven, spot, projection, seam, butt, flash and special welding equipment. (Welding News). National Electric Welding Machines Company.

(31) Asbestos Products

Given in a new catalog just issued is a complete description of industrial asbestos products. Included are construction details and engineering data tables. Material described includes insulation, refractories, floorings, roofings and sidings, asbestos walls, industrial curtains, friction materials, electrical materials, packings and gaskets. (GI-6A, 42 pages). Johns-Manville.

(32) Cranes

Pictured and described in a new bulletin are whirlers, gantry cranes, floating cranes, hoists, coal and ore bridges, unloaders and other special purpose installations. A check sheet to facilitate determination of type of crane needed by any particular plant is included. (216, 64 pages). Dravo Corporation.

(33) Water Conditioning

A handbook on water softening is the latest edition to this company's softener literature. This book describes the needs for conditioning equipment, the benefits of soft water, and gives details on water filteringprocesses, use of activated carbon, iron removal equipment, oil removal filters, aerators and degasitors, and chemical feed systems. Elgin Softener Corporation.

(34) Metal Cutting

If you want to slash your metal cutting and trimming costs from dollars to pennies you should send for a booklet that is available on friction saws. This versatile friction saw will cut varied structural shapes in any sequence without change of blade or set-up, and will permit one machine to handle

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Products and Developments

various types of work which would normally require several slow speed saws to handle. (9200). Kling Brothers Engineering Works.

(35) Voltage Stabilization

A handbook on voltage stabilization is available to you that provides the answer to a problem that confronts every manufacturer or user of electrically operated or electronic equipment. By use of the constant voltage transformer, which maintains operating voltage within plus or minus one per cent of rated requirements, regardless of supply line fluctuations as great as 30 per cent, trouble free operation of your equipment becomes a reality. This transformer is designed specifically for automatic operation requiring no supervision and with no moving parts. (GCV-102). Sola Electric Company.

(36) Dual-Tube Manometer

Now instead of standing on a stepladder, as when reading long range, single-column manometers, the operator can read high range pressures, vacuums, and differentials from the floor level. And you can read about this new manometer development in a new booklet that is available to you. The new manometer consists of two separate manometer tubes in the same case, each tube with individual well. The left tube has a scale increasing upward; the right tube a scale increasing downward. Both tubes are connected in parallel to the same pressure source. (M-100WM). The Meriam Instrument Company.

(37) Chemical Cleaning

"More Power to America's Industry" is a new color booklet describing a chemical cleaning service for steel plant operators. This method of chemically dissolving accumulated scale is the modern, rapid way to clean hearth plate cooling coils without shutting down production. The system chemically cleans cooling stack plates, bosh plates, gas scrubbers, boilers, dust precipitators, condensers, filter beds and water lines above or below the ground. Dowell, Inc.

(38) Transformer Connections

"How to Use One Bank of Transformers to Supply Two Different Loads" is the subject of a completely written paper by an electrical engineer. The paper, which is available to steel mill engineers and operators, shows a number of connection combinations by which two different loads can be supplied by one bank of transformers, and explains how to determine the size of each transformer required. The construction and use of vectors is explained. Seven typical problems are discussed, and each is solved by approximate formula and by vectors. (TU-76, 16 pages). Wagner Electric Corporation.

(39) Nickel Alloy Selector

It is useful to know that information covering a certain metal problem is available, but it is much more useful to have that information right at your fingertips in compact form. There is available a nickel alloy selector which compresses the significant data on all the "Inco" nickel alloys into very small space. By simply turning the dial and moving the slide one can compare their chemical compositions, physical constants, mechanical characteristics, and other individualized properties. The kit includes "Properties of Some Metals and Alloys," a booklet containing essential chemical, physical and metallurgical data obtained directly from the producers of 104 different metals and alloys. International Nickel Company, Inc.

(40) Rolling Mill Guides

Reprints of an article, from the steel industry's leading engineering journal, are available to you if you encircle number forty-one. The article is entitled: "Rolling Mill Guides," and sets forth some problems in the design and use of guides, concerning which little or nothing has been published. Guide design is not an exact science, but is influenced by varying conditions and requirements. The paper was prepared by a prominent roll shop superintendent in the steel industry. Youngstown Alloy Casting Corporation.

(41) Lathes

A catalog is available which describes lathes engineered to meet exacting needs for precision accuracy in all types of industries, and to maintain accuracy year after year, even under strenuous production conditions. Accuracy and long life are built into these lathes as carefully and surely as they are built into fine timepieces. Correct design is based on nearly forty years of research and experience, quality materials specially selected for specific needs, expert craftsmanship, strict inspection through all phases of production and assembly and thorough testing to rigid working tolerances. (100-d, 68 pages). South Bend Lathe Works.

(42) Bus Structures

Available to steel mill engineers and operators is a new brochure on bus structures. These bus structures are able to withstand the terrific forces generated in the event of a short circuit. No present day circuit breaker is capable of opening within short enough time to protect the bus. Short circuits are disastrous when bus failures occur. By installing an adequately strong structure you reduce this hazard to a minimum. Details on how this is possible will be found in this brochure. (4504). Delta-Star Electric Company.

(43) Control Valves

New data on "Quick-as-Wink" control valves is available in a booklet just off the press. The booklet, which is packed with factual data on control valves, gives authentic information, sizes, actions, and illustrations. The bulletin has been designed for steel mill engineers. (107, 12 pages). C. B. Hunt and Son, Inc.

(44) Labor Saver

An informative, exceedingly helpful, bulletin is available to you describing indicating and recording instruments and automatic controls. The descriptions include data on how these instruments can save you labor by doing the job automatically, with manual attention reduced to supervision only. Material saving is also discussed telling you how to control to the most desirable set requirements, eliminating excess quantities, resulting in saving of power, heat, steam, water, gas ,air and other critical materials. (46-713). Hays Corporation.

(45) Oxygen Consumption

. . . did not grow like topsy during the years 1933 to 1945, because producers of oxygen have maintained continual research and development work in its application, to assure not only efficient and economical use of it in day to day operations, but to further new uses of oxygen for lower cost production of goods. All of this is included in an interesting booklet "Oxygen — Indispensable Servant of Industry." Air Reduction.

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dry, pattern shop and boiler house, in order to insure the normal operation of the production departments once they are completed. Other priority jobs for completion are roadways and railways for bringing in construction materials, and serving the plant after it is finished. Twenty-seven miles of sidings will have to be built.

Work on the construction site was begun before the war. The outbreak of hostilities interrupted it until last year. Since the resumption of building, the walls of several factory blocks have been finished and the builders are now putting on the roofs. Other buildings are at less advanced stages; and thousands of workers are digging on the sites of huge shops for which the foundations are still to be laid.

The training of the stream of newcomers in building work is being rushed, with the skilled workers acting as instructors. Once the construction nears completion, training will be switched over to teaching the former building workers steelmaking, tube rolling and other processes in regular production.

In addition to the tube rolling mill, a number of other enterprises are also being built in Sumgait. Among those that have already gone into operation is the first full unit of the local heat and power plant. All enterprises have been planned to use local raw materials. Besides the large-scale plants, there will be numerous small ones turning out plastic articles and synthetic dyes. Car service stations, warehouses and port installations are also under construction.

Apart from the industrial construction in this new manufacturing center, building workers are busy laying out what is to be a modern city.

SILICONE RUBBER FOR GASKET MANUFACTURING

▲ Notable improvements in gaskets for drying and baking ovens may be expected by the use of silicone rubber for these applications, according to engineers of the General Electric chemical department, manufacturers and fabricators of the new material.

Outstanding because of its heat resisting qualities and flexibility at both high and low temperatures, the new material will decidedly outlast ordinary rubber or a rubber-asbestos compound now commonly used on industrial heating ovens. Tests reveal that the hardness of silicone rubber increases slightly after a year's heating at 300 F but retains considerable flexibility. A test of Buna S for 35 hours at the same temperature resulted in a hard surface, nonflexible material. This resistance to heat will markedly reduce the necessity of gasket replacements in the ovens.

The advantages of silicone rubber for gasket application are manifold. The resiliency of the material after long exposures to high temperatures will help maintain standard uniform conditions by preventing entrance of cold air or leakage of hot air from the ovens maintained under vacuum or pressure. The softness and resiliency of the silicone rubber product under high temperatures as compared to the hardness of rubber or asbestos is also a desirable factor. This eliminates the need for close machining of the steel usually required to produce a tight fit between the door and seat.

Another feature of the silicone rubber is that it will not adhere to metal or any other material in spite of its continued use at high temperatures and under oxidizing conditions. This will eliminate the possibility of any vulcanizing action to metal when submitted to high temperatures. The chemical inertness of the silicone rubber is further evidenced by its nongassing characteristics under high vacuum at elevated temperatures.

The General Electric Plastics Divisions, Pittsfield, Massachusets, produces silicone rubber in a variety of extruded shapes and sizes including round, square, flat and tubular.

—E-9—

LARGER MAXIMUM BORE IN NEW GEAR COUPLING

▲ Designed for much larger maximum bore than previous models, series A gear type coupling permits use of smaller sized couplings than would ordinarily be required. These consume less space, require less shaft extension, and cost less.

Coupling is steel, made to close tolerances, dustproof and oil-tight. Identical externally geared hubs key to shafts. It is enclosed by one-piece male and female sleeves that function as single rigid unit. Coupling compensates for misalignment without adding stress to shaft or bearings. It is constructed in standard, heavy duty, marine, mill motor, floating shaft, Jordan, shear pin, oil collector and cut-out types. It is made by John Waldron Corporation, New Brunswick, New Jersey.

—E-10—

REVERSE RADAR LOCATES INVISIBLE METAL DEFECTS

▲ The amazing experience of looking right into the "innards" of solid metal many feet in length and depth will shortly be a matter of routine to Illinois Central workers at the railroad's Markham locomotive shops, Chicago, Illinois. The experimental installation of the necessary sound-wave equipment was arranged to detect and locate invisible defects that may have developed in metal parts in the course of manufacture or after use. This testing device utilizes an aimed echo, the progress of which is pictured as a wave of light visible on a special viewer, called an oscilloscope. As the source of the echo is moved around upon the surface of the metal to be tested, interior defects appear as interruptions of the wave. These can be accurately measured as certain distances from the start of the sound and from adjoining surfaces.

The principle of operation is similar to radar in reverse. Radar locates solid objects in air, while this testing machine locates so-called "air" in solid objects. Any unexpected surface encountered, no matter how deeply buried, interrupts the sound and breaks the uniformity of the wave of light.

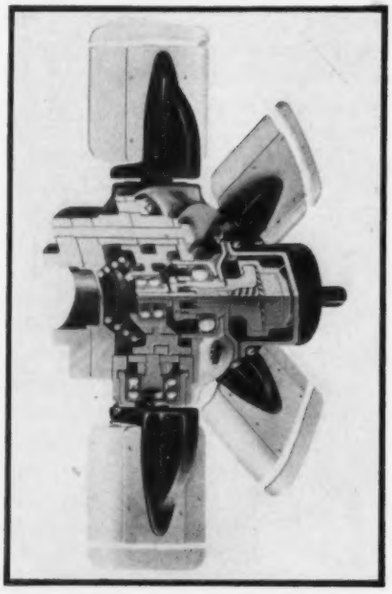
The effective depth of steel that can be tested by the new machine is estimated to be twenty-five feet. On certain other metals the penetration is even deeper. Basic to the tests are sound waves developed by electrical impulses to a quartz crystal, which is held against and moved over the metal being inspected. Since the entire machine known as the "Sperry Supersonic Reflectoscope," is portable, it can locate defects even when the parts tested are in position on a locomotive or car. Hitherto the railroad has had no satisfactory means of testing metal parts in pressed fits, such as in crank-pins and axles, after their assembly and while in use. The parts in the past have had to be separated for surface inspection.

—E-11—

FAN INSTALLATIONS FOR EXISTING ENGINE MOUNTS

▲ A front operating adapter design of the thermal power element in the "Thermo-Control" fan has been released for production, the Thermo-Aire division of Evans Products Company, Detroit, Michigan, announces.

This new model has been engineered to simplify installation of the fan in existing engine mounts when necessary clearances are available. To install the new model, it is only necessary to remove the old fan from the fan hub and remount the fan with the correct mounting flange to fit the hub.



The fan is a variable pitch self-adjusting fan operated by a built-in thermal power element. Adjusting itself to changes in engine and ambient temperature, the fan maintains near constant engine operating temperature, increasing horsepower output, reducing fuel, lubricating oil and maintenance costs and eliminating nearly all formation of sludge deposits in engine and lubricating oil. The fan is manufactured in four, six and eight blade models.

—E-12—

OVERSIZE EXCITER USED IN WELDING GENERATOR

▲ For many years, The Hobart Brothers Company, Troy, Ohio, has been building gasoline driven arc welders with inbuilt auxiliary d-c generators of 115 volt and 230 volt capacities. These units are used as sources of auxiliary power.

A new development is a 300 ampere gasoline driven arc welder with an inbuilt auxiliary a-c generator. This compact, high performing design has resulted by taking advantage of an oversize separate exciter, using it to supply excitation to both the welding generator and the a-c generator. With the clever arrangement of connecting the stations and panel of the generator, it is possible to furnish many combinations of power simultaneously: The panel provides receptacles and studs for connecting to the power required, an a-c voltmeter with dual scale, frequency meter, and rheostat for controlling the a-c voltage. This auxiliary a-c generator is available in two sizes, 6 and 12 kw.

—E-13—

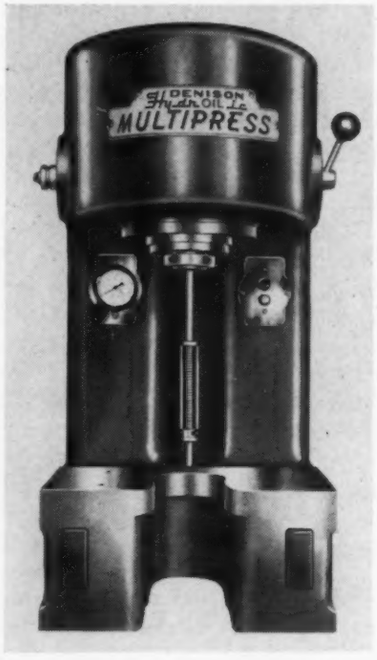
VIBRATORY PRINCIPLE IN HYDRAULIC PRESSURE UNIT

▲ Engineers of the Denison Engineering Company, Columbus, Ohio, have developed the vibratory "Hydroilic" pressure principle, which affords a startlingly new degree of control and application of hydraulic power or pressure applied to a moving machine element. The first industrial application of this principle is in the "Multi-press." In this unit the pressure principle is applied to the control and action of the press ram. This control and action permits regulating the ram so that it will automatically make any number of short repeated pressure strokes upon contact with the work. In other words, the operator, by merely depressing the press control levers, brings the ram down upon the work and without further movement of the levers the ram automatically makes short repeated pressure strokes until the control levers are released by the operator.

These short strokes are regulative in length anywhere between a few thousandths of an inch and ½ inch. Their frequency naturally depends upon length of stroke and ram speed. Some idea may be gained of this frequency from the fact that the press will make five hundred 4-ton pressure strokes per minute at the ⅛-inch stroke setting. Any lesser setting of stroke length increases stroke frequency to virtually vibration. Extremely important is the fact that all of these short repeat strokes are uniform in the pressure exerted by the ram.

No matter how greatly the work may be compressed during this repeat action, the ram will follow it downward, exerting the same uniform pressure and these pressures are closely regulative anywhere between 1600 pounds and 8000 pounds.

Automatic cycling has been combined with pressure and this combination affords even more unusual ram action. With automatic cycling, only one hand lever is used to control the unit, this lever having five operating positions: single cycle, automatic cycling, hold-down, emergency reverse and idling. Through it the operator of the press can set up his work



and then bring into play the automatic cycling features. For example, the press has a 6-inch maximum stroke. He may find that the particular pieces upon which he is working require that the ram rise only 4 inches for proper feeding clearance. Through a simple adjustment, he can limit the upstroke of the ram to 4 inches, instead of the full 6 in. This will naturally increase frequency of strokes. Then he may preset the maximum pressure to be exerted on any piece of the work and, as stated above, this limit may be anywhere between 1600 and 8000 pounds. By trial, he has probably found that a certain number of repeat strokes on the work is the "ideal," and by simple knurled-knob adjustment, he may regulate the ram to make exactly that number of repeat strokes during any one complete cycle. Let us say he has chosen 10 repeat strokes as the "ideal." The

nature of the work may indicate to him that the repeat strokes should be ¼ inch in length. Through another knurled knob, he regulates the ram to rise from the work only ¼ inch upon every stroke. He is now ready to proceed with the press functioning automatically. He throws the control lever to automatic cycling position, the ram descends upon the work, makes 10 repeated ¼-inch strokes upon the work, exerting uniform pressure upon every stroke, and then rises 4 inches to its uppermost position.

—E-14—

Book Reviews

▲ A complete yet concise treatment of fluid measurement, including related factors, equipment, equations and computations in terms of steam, water, oil and gas flow, is offered in a new volume, The Flow Meter Engineering Handbook, compiled and edited by Louis Gess and R. D. Irwin, flow meter engineering department, Brown Instrument Company division of Minneapolis-Honeywell Regulator Company. The new volume, replete with information for students as well as engineers, is the second edition published by the Brown Company.

The first chapter discusses principles of orifice meter measurement followed by succeeding chapters on the orifice plate and differential connections, design details of Brown flow meters, flow approximation tables, derivations of working formula, working equations, compressibility of gases, relationship between coefficient of discharge, viscosity of fluids and orifice calculations for steam, water, oil and gas flow.

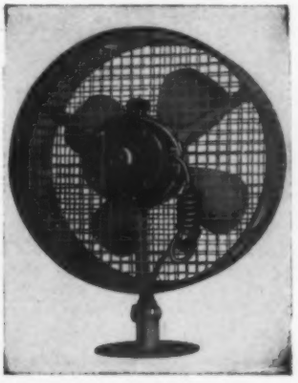
The final chapters are given over to a summary of equations and nomenclature, changes for corrections in operating conditions, and volume computations. Thirty-eight figures and 55 tables are included in the book's 151 pages. The Flow Meter Engineering Handbook is being published by the Brown Instrument Company, Philadelphia. It is priced at $2.50 a copy.

▲ All engineers familiar with the previous editions will welcome the 24th edition of the Heating Ventilating Air Conditioning Guide published by the American Society of Heating and Ventilating Engineers, 51 Madison Avenue, New York, New York, is just off the press. The technical text contains 51 chapters grouped under the general section headings of: principles, human reaction to atmospheric environment, heating and cooling loads, combustion and consumption of fuels, heating systems and equipment, air conditioning, special applications, and installation and testing codes.

New material from society sponsored research on air flow in outlets has been added to the chapter on air distribution. A new air friction chart based on studies has been prepared for the chapter on air duct design. To the chapter on hot water heating systems and piping has been added a chart showing pipe flow in pounds of water based on friction loss.

The guide contains 904 pages of technical text, 376 pages of equipment data, and the roll of membership of the Society. The price of the guide is $6.00.

IS HEAT SLOWING UP YOUR WORKMEN?



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ENGINEERS ORGANIZE CONSTRUCTION PARTNERSHIP

The R. T. Patterson and Company, a partnership of engineers and constructors, has been newly formed. The firm offers experienced technical service on the installation of industrial, mechanical and electrical equipment, and the engineering service on such work. Members of the organization have had wide experience in ferrous and non-ferrous rolling mill engineering and construction, and in design and construction of chemical plants, foundries, and coal mines and tipples. The headquarters are in 703 Pitt National Bank Building, Pittsburgh 22, Pennsylvania. The partners are R. T. Patterson and F. Mohler; manager, sales and engineering will be Walker Anderson; H. A. Bernhagen will be chief engineer; and Wray Dudley will be project engineer.

R. T. Patterson has had a wide experience in engineering and construction work. In 1928 he was electrical engineer for Dwight P. Robinson Company during the installation of the hot strip mill for the American Rolling Mill Company at Middletown, Ohio. He then became construction foreman for Westinghouse Electric Corporation on the electrical equipment at Rotary Electric Steel Company in Detroit and then became electrical foreman for Great Lakes Steel Corporation, Ecorse, Michigan, during the construction of their hot strip mill.

From 1936 to 1941, Mr. Patterson was construction engineer for General Electric Company in the Pittsburgh district during which period he was in charge of installing the electrical equipment for the hot strip mill of Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania. He then was a construction superintendent for all electrical work on the hot and cold strip mills at Irvin Works of Carnegie-Illinois Steel Corporation. Upon completion of this work he was chosen chief engineer in charge of installation of aluminum mills for Reynolds Alloy Company, at Spokane, Washington.

F. Mohler started with the General Electric Company in July 1926 in the test engineering course. In July 1928 he went to the industrial control engineering department where he designed various types of controls for steel mill applications. He next went to the industrial engineering department as an application engineer, in which capacity he engineered and started up strip mills at Jones and Laughlin Steel Corporation's Pittsburgh works, at the Irvin works of Carnegie-Illinois Steel Corporation, at Brier Hill and Campbell works of Youngstown Sheet and Tube Company, and at the Hamilton plant of the Dominion Foundry and Steel Company (Canada). He also pioneered the introduction to industry of the "Amplidyne," a radically new type of rotating regulator. In 1940 he was made engineer in charge of the steel mill division.

Walker Anderson entered the employ of General Electric Company at Schenectady, New York, where he participated in their test course. In August 1915 he was transferred to the industrial control engineering department, and in September 1916 went into the industrial control commercial division for training as a specialist in industrial control. This engagement was interrupted from April 1917 to January 1919 by service as a lieutenant with the United States Army during World War I. In July 1919 he went to the Pittsburgh office of the General Electric Company as industrial control specialist, and later became industrial heating specialist.

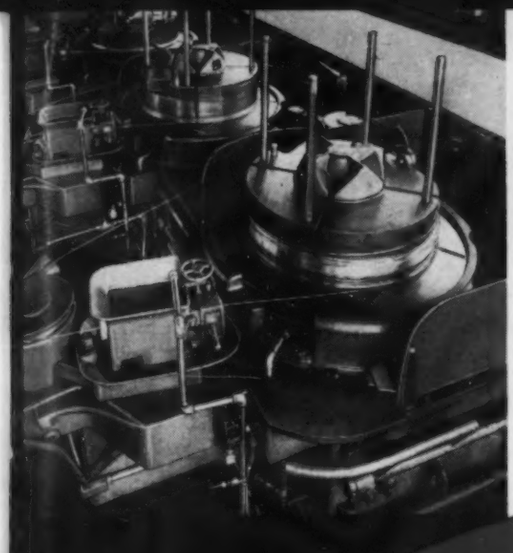
H. A. Bernhagen was employed from 1926 until 1930 as a draftsman for the Richmond Radiator Company. In June 1930 he was employed as engineer and designer by the Ricks Manufacturing and Supply Company, Uniontown, Pennsylvania. In March 1943 he was in the service of E. I. DuPont de Nemours Company, Inc., Morgantown, West Virginia. He returned in March 1944 to the Richmond Radiator Company, Uniontown, Pennsylvania. Mr. Bernhagen's experience has been extensive in the design and construction of chemical plants, foundries, and coal mines and tipples.

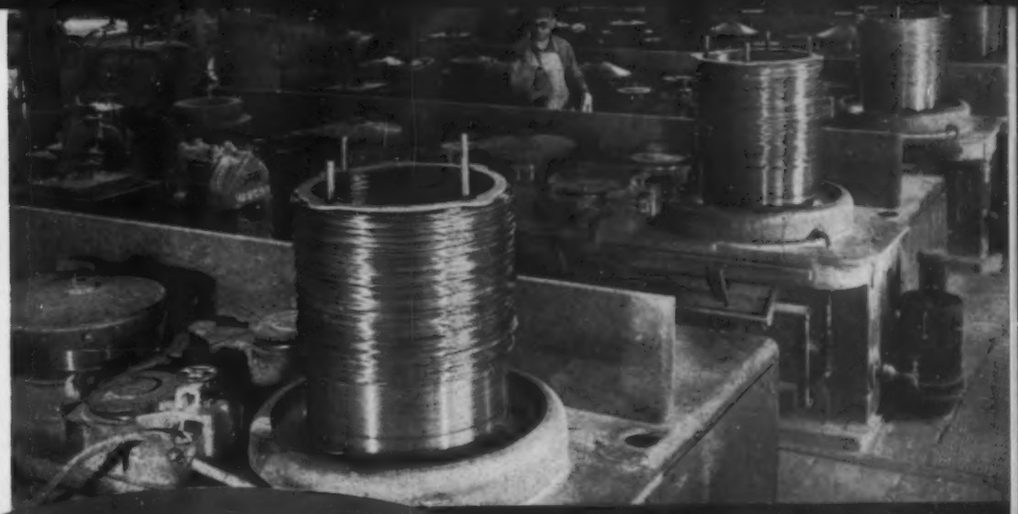
Wray Dudley graduated from the University of Missouri with a bachelor of science degree in electrical engineering in 1905. He was with the test course and construction department at General Electric Company from 1905 until 1910, when he became district engineer in the Pittsburgh office. In 1917, he was appointed electrical superintendent at the Ashland Iron and Mining Company in Ashland, Kentucky. From 1921 until 1927 he was electrical superintendent at the Ashland works of the American Rolling Mill Company. He was then employed by National Tube Company as an electrical engineer on special development work and in 1936 he became electrical superintendent of the National works of National Tube Company. In 1941, he was appointed assistant superintendent of maintenance. He moved to the Lorain, Ohio, works of National Tube Company in 1945 to make a power study.

R. T. PATTERSON and F. MOHLER are partners in the new organization.

WALKER ANDERSON is manager, sales and engineering: H. A. BERNHAGEN is chief engineer; and WRAY DUDLEY is project engineer.

BUD SCOTT PHOTOS





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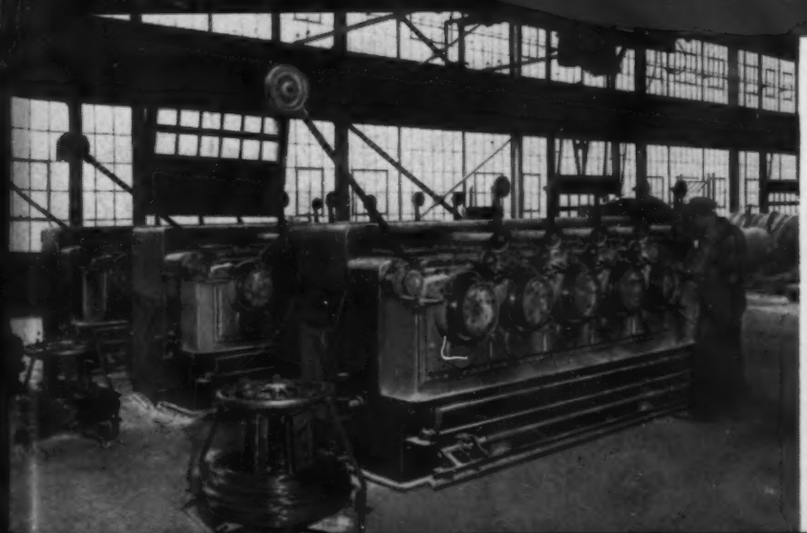

AISE

SPRING CONFERENCE

Roundup

Sponsored by the Rolling Mill Committee of the AISE, the Annual Spring Conference was held May 6 and 7 in the Congress Hotel, Chicago, Illinois. Over 450 members and guests registered for this meeting which included technical papers on rolling mill subjects and an inspection trip to DPC Plancor 422 operated by the Republic Steel Corporation. The speaker at a dinner held May 6 was Walter Duranty, noted foreign correspondent and journalist who is shown in center (1) talking to the AISE president Freeman H. Dyke and C. L. McGranahan. In (2) Thomas N. Sloan and James G. Meenan discuss the merits of die rolling. Harmony between the various branches of steel plant operation appears in (3) with H. V. Lauer, president of the Blast Furnace and Coke Association of the Chicago District, Alex Montgomery, Jr., chairman of the AISE Rolling Mill Committee, and E. L. Ramsey, chairman of the AIME Open Hearth Committee. A. J. Whitcomb in (4) welds international relations with the long distance champions: J. J. B. Blomb and T. L. Roux, both of the South African Iron and Steel Corporation. R. J. Finnie (5) is apparently enjoying a yarn with Steve Swetonic. The program gets an audience with B. L. Jones, L. F. McCaffrey and C. S. Mushinski (6). In (7) W. B. Hackett, H. F. Dischinger, J. L. Campbell and A. E. Murton are shown in Peacock Alley of the Congress Hotel waiting for the inspection trip. Outside the Florentine Room, where the technical sessions were held, are (8) Wade F. Hoffman, A. R. Provan, J. Ralph Patterson, Fred S. High and F. E. Walling. Richard W. Berg and Alfred G. Bartlett (9) are discussing bearings, while rounding up the conference (10) are W. H. Seaman, F. F. Zipf, W. C. Berg, Jr. and E. L. Wright.

BUD SCOTT PHOTOS

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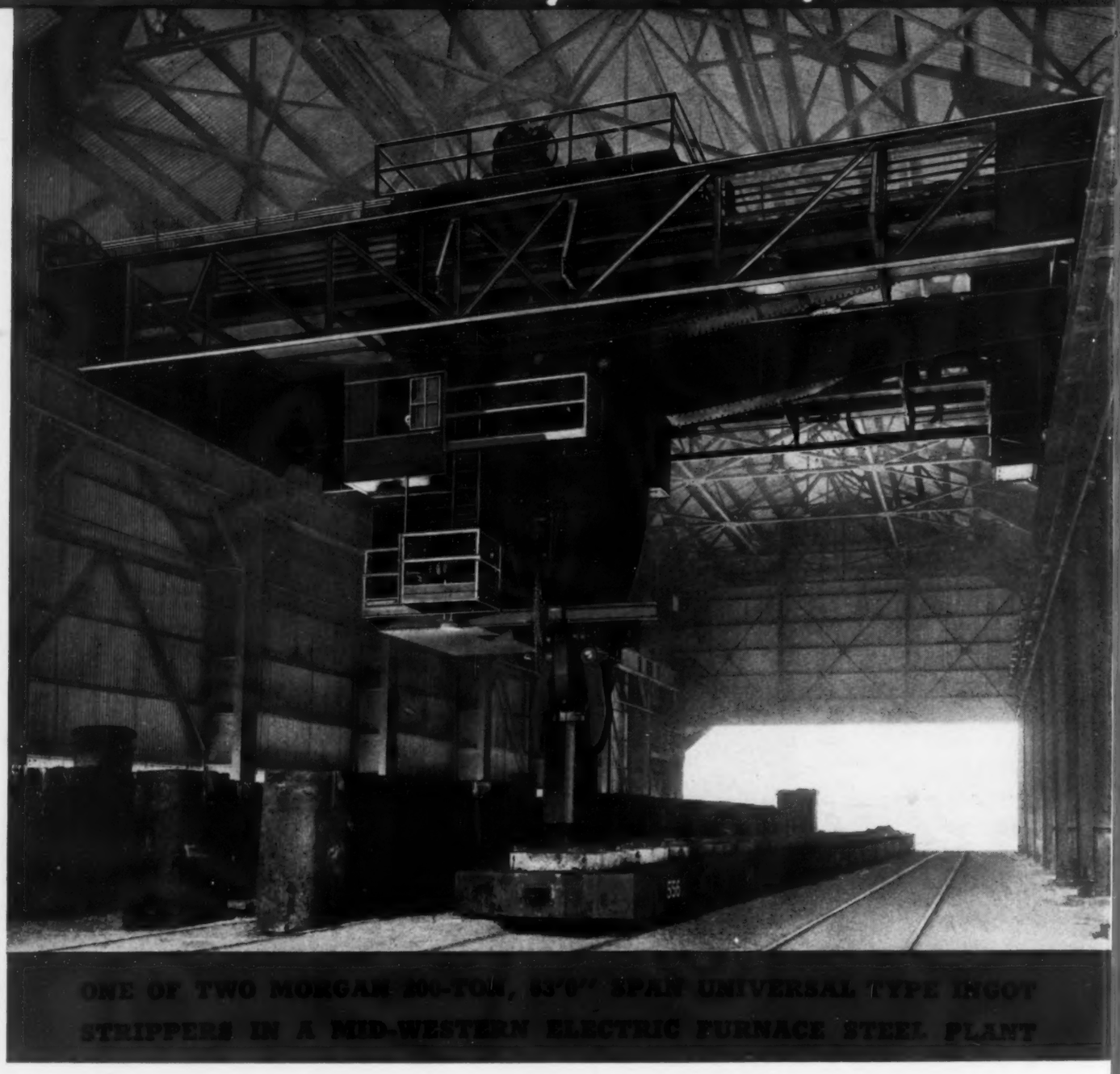
Engineering



ONE OF TWO MORGAN 300-TON, 83'0" SPAN UNIVERSAL TYPE INGOT STRIPPERS IN A MID-WESTERN ELECTRIC FURNACE STEEL PLANT

The Stripper as illustrated will perform three distinct stripping operations without change in the stripping unit.

(1) Strip small-end-up or standard ingots.
(2) Strip big-end-up hot top ingots.
(3) Break small-end-up ingots loose from stools.

With this type of Stripper it is possible to strip a mixed heat without lost time.

Additional Morgan equipment in this plant includes: Two 300-Ton, 65'0" Span Pouring Cranes. Three 150-Ton, 65'0" Span Pouring Cranes. Two 150-Ton, 80'3" Span Hot Metal Charging Cranes.

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Personnel News

Carl W. Muhlenbruch, associate professor of civil engineering at Carnegie Institute of Technology, has been selected by the American Society for Testing Materials to receive its Sanford E. Thompson Award for 1946. The award honors the authors of papers of outstanding merit on concrete.

Mr. Muhlenbruch is in direct charge of the Association of Iron and Steel Engineers' research investigation on the stresses and design of crane ladle hooks.

Tom J. Peters was appointed division superintendent of maintenance at Carnegie-Illinois Steel Corporation's South Chicago, Illinois, plant. Formerly assistant to general superintendent, he succeeds **John S. Townsend** who resigned.

An electrical engineer, Mr. Peters has been associated with the corporation's South Chicago plant for the last 16 years. He started as a testing engineer in the electrical department and since has advanced through various positions including that of assistant division superintendent of plant maintenance. He has been assistant to general superintendent since last April.

H. E. Boedecker was recently appointed superintendent of shops at the Indiana Harbor, Indiana, works of the Youngstown Sheet and Tube Company. Mr. Boedecker will be responsible for the shops at the steel works, coke plant and tin mills. Until recently he was assistant general superintendent of Pittsburgh Metallurgical Company, Charleston, South Carolina. Prior to that he had been superintendent of electrical and mechanical departments at Atlas Steels Limited, Welland, Canada.

Mr. Boedecker first entered the steel industry in the tube mill electrical department at the La Belle Iron works, now a part of the Wheeling Steel Corporation. After brief periods at the Farrell works of Carnegie-Illinois Steel Corporation, and the Middletown plant of American Rolling Mill Company, Mr. Boedecker became connected with Tennessee Coal, Iron and Railroad Company. Following two years in the electrical department of Wisconsin Steel Company and two years in electrical construction with Jones and Laughlin Steel Corporation, Mr. Boedecker joined the organization of the Crucible Steel Company of America at Pittsburgh where he served 15 years.

Martin J. Conway has entered general consulting engineering with headquarters at Gap, Pennsylvania Mr. Conway, for the past few years, has represented Lukens Steel Company, Coatesville, Pennsylvania, as a sales research engineer. He formerly had been fuel engineer for this company. In 1928 he was sent by Lukens to Europe for special metallurgical investigation. From 1923 to 1926, prior to going with Lukens Steel Company, Mr. Conway was fuel engineer for the Steubenville, Ohio, plant of the Wheeling Steel Corporation. Prior to 1923 he had been fuel engineer for four years at the Pittsburgh Crucible Steel Company, Midland, Pennsylvania. He was educated at Hanley and Oxford in England.

David Adams was appointed assistant secretary and assistant treasurer of the Tennessee Coal, Iron and Railroad Company. Mr. Adams, a native of Jackson, Albama, attended elementary and high schools in Jackson and was graduated from the University of Alabama with a bachelor of science degree in Commerce in 1923. From 1923 until 1940 he was with the bank of Pine Apple, Alabama, where he was vice president and cashier when he left to become executive vice president of the American National Bank at Gadsden, which position he left to join Tennessee Coal, Iron and Railroad Company last July.

H. H. Shakely, formerly general master mechanic of strip mills at Jones and Laughlin Steel Corporation's Pittsburgh, Pennsylvania, works, has been appointed assistant superintendent of maintenance of the Pittsburgh works.

TOM J. PETERS

H. E. BOEDECKER

MARTIN J. CONWAY

WILLIAM G. HALL

ARTHUR W. RAY

GRAYDON MEGAN

William G. Hall, who has been in charge of renewal parts and repairs for the Reliance Electric and Engineering Company, during the war years, has been made manager of a combined renewal parts and service division.

In his enlarged responsibilities, Mr. Hall succeeds **Arthur W. Ray,** who retires after completing 40 years with Reliance, the past 21 of them as service manager.

Born in Cleveland, Mr. Hall graduated as an electrical engineer from Case School of Applied Science in 1934, supplementing this in 1943 with the professional degree of electrical engineer, from the same institution. Hall came to the engineering department of Reliance in 1937, transferring four years later to the company's service department.

Graydon Megan of Chicago has been elected secretary of the Inland Steel Company. He succeeds **J. H. Morris,** who is retiring after 28 years with Inland. Mr. Megan, a graduate of University of Chicago Law

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School joined Inland in 1938. He returned last October after three and one-half years with the United States Army, where he rose from private to captain in the field artillery, serving in the European theater.

H. E. Widdell was elected president of the Arthur G. McKee and Company on April 16. Mr. Widdell's first connection with the McKee company was in 1925. At that time, Arthur G. McKee and Company, seeking to enter the petroleum refining field, became associated with the Widdell Engineering Company, a company prominent in the design and construction of petroleum refining plants, of which Mr. Widdell was the principal owner. Several years later, Widdell Engineering Company was absorbed by Arthur G. McKee and Company and since then Mr. Widdell has been a director and a vice president of the McKee company.

Mr. Arthur G. McKee will continue to participate in the affairs of the company as chairman of the advisory committee of the board of directors, the other members of this committee being Mr. Widdell and **Robert E. Baker,** secretary-treasurer, one of the original partners of the McKee organization. Mr. McKee has been head of the organization for more than 40 years. The business was established in 1905 when, Mr. McKee as a consulting and contracting engineer, opened an office in Cleveland, Ohio, to serve the iron and steel industry. From that beginning, the scope of the activities of the McKee Company has grown to embrace the complete design and construction of all kinds of iron, steel and petroleum refining plants, and the company is now one of the leading engineering and construction companies both in this country and in foreign countries in the fields which it serves.

Harold C. Lindberg was appointed engineer of the Buffalo, New York office, General Electric Company. Mr. Lindberg is secretary of the Buffalo District Section of the Association of Iron and Steel Engineers.

Herman H. Dejadon, Maurice R. Ely and **Edward C. Otto** have formed a manufacturers' agency under the name of D-E-O Industrial Products, with offices at 2701 West Madison Street, Chicago, Illinois. For the past ten years Herman Dejadon has been a sales representative of the McKinley-Mockenhaupt Company in the Chicago area. Before that he was connected with the Daniel Woodhead Company and other electrical firms in the New York and New England territories.

During the last two and a half years, Maurice Ely was executive secretary of the National Electric Sign Association. Prior to that he was with Sylvania Electric Products, Inc., for a year and for 17 years he served as secretary of the Electrical Maintenance Engineers and the West Suburban Electric League.

Edward Otto has been a sales representative for the Chicago Rawhide Company for the past two years. Previous to that he represented the Crouse-Hinds Company in the Chicago region for 28 years.

The new organization will represent the following companies: Adalet Manufacturing Company; Dow Pneumatic Tool Company; Dubois Engineering and Manufacturing Company; and Electric Service Engineering Company.

The IMO PUMP provides a maximum of capacity in a minimum of space due to the fact that it can be operated at high speeds connected directly to motor, turbine or other machinery.

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- Electrodes used in production of electrically welded pipe or tubing.
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W. T. Kelly, Jr., will direct the new Rochester plant of the American Brake Shoe Company which was recently purchased from the Progressive Foundry Works, Inc., Rochester, New York. The plant has been producing specialty grey iron castings for many years for industry. Under American Brake Shoe management, the foundry will continue to produce castings made by the process recently developed at their metallurgical research laboratory.

John C. Lerach, veteran of 34 years of service with the American Steel and Wire Company, and other United States Steel subsidiaries, has been appointed district traffic manager at Pittsburgh for the wire company. He formerly was associated with the Oil Well Supply Company, Great Northern Railway and Pennsylvania Railroad. Mr. Lerach joined the American Steel and Wire Company in 1912 and ever since that time has been active in the field of traffic and transportation. Starting as a routing clerk, he advanced to the post of chief traffic clerk in 1930. Two years later he transferred to United States Steel Corporation subsidiaries as a rate clerk.

George W. Frick was appointed executive vice president of the Carbide Die and Mold Company. Mr. Frick will also direct the company's sales. The firm manufactures precision sintered carbide dies and molds, wear parts, and special tools for the powdered metals, ceramics, and other fields. Mr. Frick recently resigned as general manager of sales of the Firth-Sterling Steel Company.

Dr. Louis C. McCabe, an authority on the mining, preparation and properties of coal, joined the Bureau of Mines staff recently as chief of the coal division in the fuels and explosives branch. In his new position, Dr. McCabe will supervise the bureau's research on the mining, preparation, carbonization, and gasification of coal and kindred subjects at experiment stations and pilot plants in various parts of the country. Formerly a member of the staff of the coal division of the Illinois Geological Survey, Dr. McCabe performed outstanding service in fuels and heating, for the armed forces. During the last months of the war he was chief of the solid fuels section of the United States Forces, European Theater.

James A. Darrow, general superintendent of the Joliet Works of the American Steel and Wire Company received a gold medal commemorating his fiftieth year of wire making. Mr. Darrow's service to the industry began in 1896 at the Waukegan plant of the Washburn and Moen Manufacturing Company which was taken over by the American Steel and Wire Company in 1899, just two years before the wire company itself became an integral part of the United States Steel Corporation. In 1936 he was promoted to general superintendent of the Joliet Works leaving his position as assistant general superintendent at Waukegan.

(*Please turn to page 122*)

You can get what you want in the complete range of Jones Herringbone Speed Reducers

YOU will find this 128-page catalog of Jones Herringbone Speed Reducers helpful in the selection of reducers in accordance with A.G.M.A. recommended practice for all conditions of service. Jones Herringbone Speed Reducers are built in single, double and triple reduction types and in every standard ratio in ratings ranging from 1.25 H.P. to 440 H.P.

All these reducers have heat treated gears, ground shafts and are mounted with anti-friction bearings throughout. Liberal stocks are carried to facilitate shipments.

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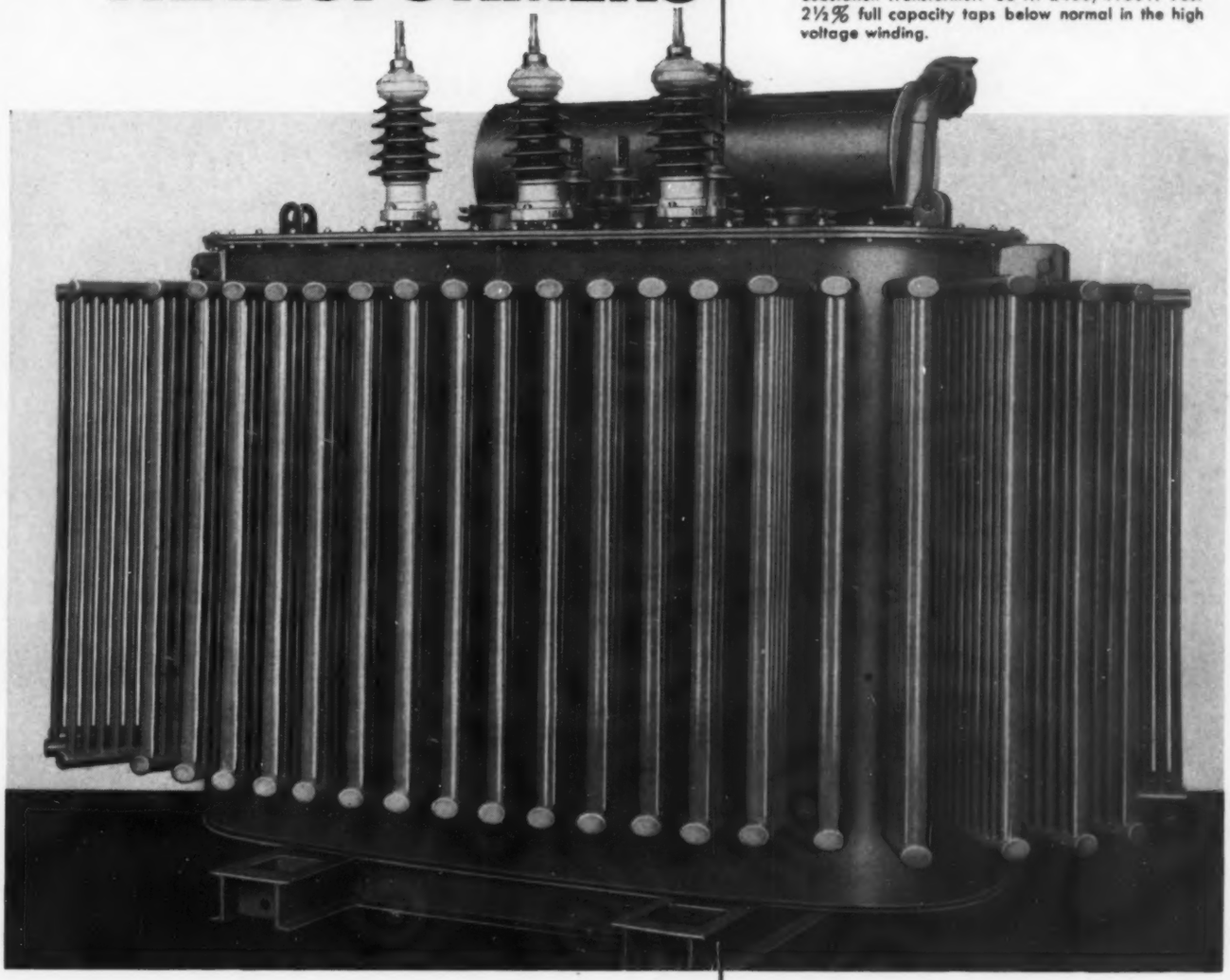
SUBSTATION TRANSFORMERS

3000 Kva, 3-phase, 60 cycle, 55°C, OISC, Outdoor Substation Transformer. 33 Kv-2400/4160Y. Four 2½% full capacity taps below normal in the high voltage winding.



Check the following features of this typical Pennsylvania 3-phase Substation Transformer:

- Specially treated resin-bonded cork gasket forms oil-tight seal between copper-bearing steel cover and top tank flange.
- Removable pin-type lift lugs for lifting cover, core and coils as a unit.
- Removable pin-type lift lugs for lifting complete transformer.
- Permanently welded radiators with radiator headers of No. 11 gauge steel.
- Radiator tubes of No. 13 gauge steel resist fractures, punctures and corrosion.
- Heavy structural steel base designed for easy jacking and for rolling transformer in any direction.
- Frangible disc, self-reclosing safety valve.
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Pennsylvania TRANSFORMERS

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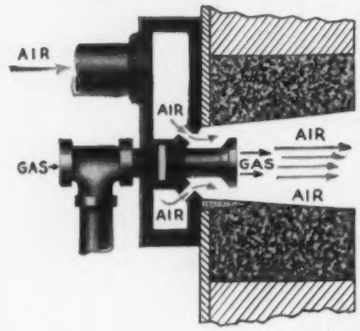
THE BLOOM TEMPERED-FLAME BURNER



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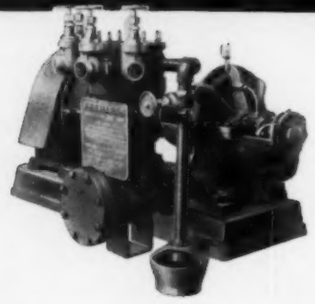

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FRANCIS M. RICH

Francis M. Rich, formerly with The Steel Company of Canada, Ltd., as vice president in charge of operations at the iron and steel plant of Kaiser Company, Inc., Fontana, California will succeed **Peer D. Nielsen,** nationally known figure in the industry, who died February 28 of injuries received in an automobile accident.

Mr. Rich has a background of more than 20 years' experience in the iron and steel industry in the United States and Canada and has won recognition for outstanding work in the field. In 1935 he was presented the J. E. Johnson, Jr. award by the American Society of Mining and Metallurgical Engineers for his efforts in blast furnace development and improved production methods.

Born and reared in Chicago, his career started at the South Works of the Illinois Steel Company (now the Carnegie-Illinois Steel Corporation) immediately following graduation in 1925 from the University of Illinois, where he obtained the degree of bachelor of science in mechanical engineering.

From the Illinois Steel Company, where he learned the trade through practical experience as a stove tender and blower, Mr. Rich advanced rapidly and in 1929 joined the Wisconsin Steel Company as assistant to the open hearth superintendent.

Later with Republic Steel Corporation, he served as superintendent of blast furnaces of Republic's Buffalo district until 1938. In 1938, he accepted the position of assistant to the vice president and works manager of The Steel Company of Canada, Ltd., and in 1943 he was made assistant works manager of the Hamilton works of the same company, which office he held until his present appointment with Kaiser Steel.

Vernon E. Piez, who was previously assistant works manager, has been designated assistant sales manager, American Car and Foundry Company, New York, New York.

William G. Stolberg, recently discharged as a lieutenant in the United States Navy, has been designated as assistant works manager, American Car and Foundry Company, Detroit, Michigan.

William S. Major of Philadelphia, Pennsylvania, was appointed development engineer for Bituminous Coal Research, Inc. Well known in the power field after 20 years of service with American Engineering Company, manufacturers of industrial stokers, Mr. Major will be responsible for promoting various research projects that have progressed far enough to justify commercial trial or use.

After graduating in 1924 from Lehigh University, where he received a bachelor of science degree in chemical engineering, Mr. Major first engaged in research work on briquetting of coal. In 1925 he joined the Philadelphia office staff of American Engineering, working in the engineering, estimating and field service departments until 1928. He then served the same company as district manager at Cincinnati, Ohio, from 1928 through 1939, at which time he was appointed district manager at Chicago, where he served until 1941. In August of that year, he was transferred to Philadelphia as assistant to general sales manager, American Engineering, to supervise district offices and agencies, prepare sales manuals as well as analyses and reports on fuel economies for industrial power plants, conduct sales engineering conferences and carry on market research on power plant trends.

KASIMIR OGANOWSKI

Kasimir Oganowski was appointed associate director of research laboratories of the American Rolling Mill Company, Middletown, Ohio. Mr. Oganowski joined the company as a consultant in 1936. A graduate engineer of Politechnika Waszawska, Warsaw, Poland, he was previously employed by a Polish steel company. For the past six years he has been supervising metallurgist at American Rolling Mill Company. He will be in charge of the development of all metallic coated products throughout the company, such as galvanized, lead-coated and aluminum-coated metals.

John H. Loux has been appointed branch manager of the Loftus Engineering Corporation at the branch office in Chicago, Illinois. Mr. Loux was formerly with Salem Engineering Company, Salem, Ohio.

(*Please turn to page 125*)

to help you find the flexible couplings you need -

LOVEJOY L-R QUICK FINDING SELECTOR CHARTS

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These charts show you your exact coupling requirements at a glance—without tedious figuring. Complete data—weights, prices, etc. Have these accurate, time-saving charts in your files for reference.

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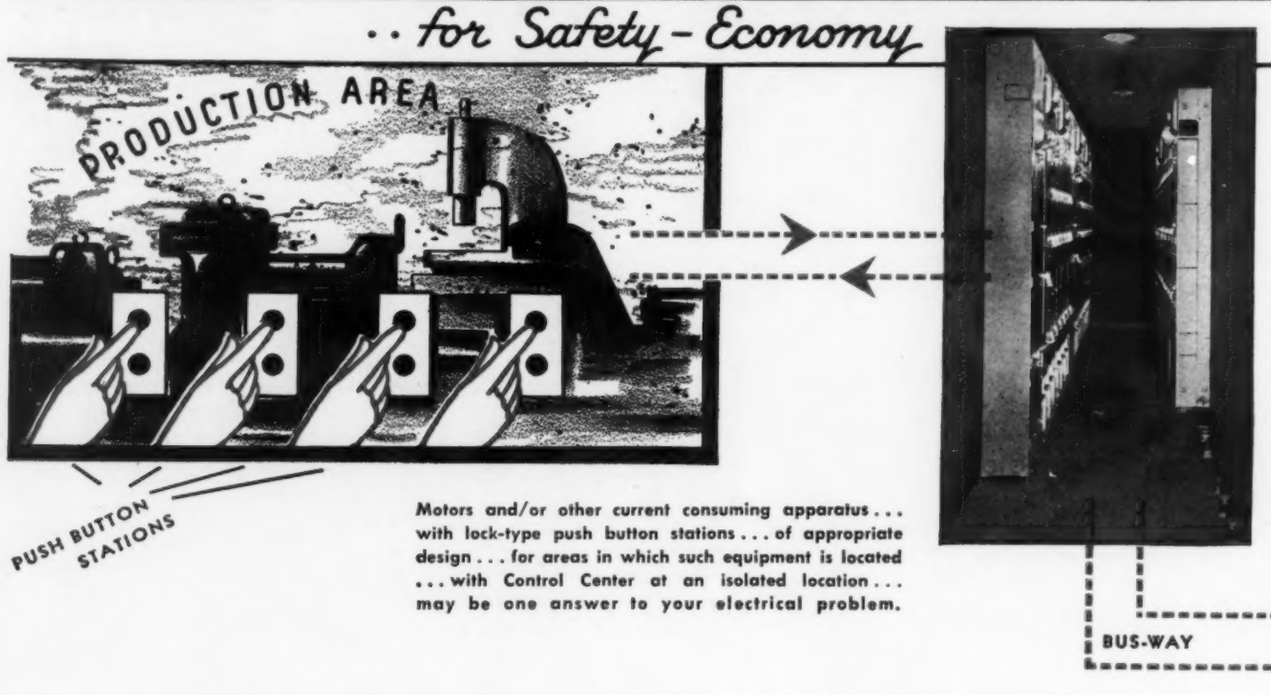
ISOLATION OF CONTROL

.. for Safety - Economy



Motors and/or other current consuming apparatus . . . with lock-type push button stations . . . of appropriate design . . . for areas in which such equipment is located . . . with Control Center at an isolated location . . . may be one answer to your electrical problem.

Many industrial atmospheres are enemies of electrical control apparatus. The presence of dirt, dust, vapors, moisture, etc., may make it advisable to consider the location of only a minimum amount of control equipment in your actual working areas. Motors . . . YES; Push buttons for start and stop of such motors . . . YES; but actual Control, Disconnect, Short Circuit and Over-Current Protection . . . NO. These functions can be located AWAY from actual working areas, where apparatus can be installed without sacrifice of productive square feet . . . and where maintenance and inspection are facilitated.

In other words, Trumbull will take your safety switches, circuit breakers, controllers and main bus bar structures . . . wrap them up in Steel . . . and build you a Control Center to be located *away* from *trouble.*

Diagram above shows Production Area containing only motors and push button stations. Removed from troublesome atmospheres, the Control Center is Guardian of the whole situation.

THE TRUMBULL ELECTRIC MANUFACTURING CO.

PLAINVILLE, CONNECTICUT

OTHER FACTORIES AT

NORWOOD, OHIO — LOS ANGELES — SAN FRANCISCO — SEATTLE

R. W. Biggs has been named works manager of the Ambridge, Pennsylvania, plant of National Electric Products Corporation, succeeding **Neil C. Lamont** who has reached retirement age. The new works manager is a graduate of Ohio Northern University, Ada, Ohio. His first production responsibility was in the Lorain, Ohio, works of National Tube Company.

In 1938 he became assistant superintendent of the Jones and Laughlin Steel Corporation works in Aliquippa, Pennsylvania. Five years later, Mr. Biggs was advanced to the post of production manager of the J. & L. McKeesport, Pennsylania works. During 1944-45 he served as works manager.

For the last five months Mr. Biggs has been in the Pittsburgh general offices of National Electric Products Corporation in an administrative capacity.

Boyd Watson, district manager of the New York office of the Spang-Chalfant division of The National Supply Company, Pittsburgh, Pennsylvania, retired after 41 years with the division and its predecessor, Spang Chalfant, Inc. **W. J. Stanton,** who has been with the company for 14 years, will succeed Mr. Watson. Mr. Stanton was the company's liaison representative in Washington from 1941 throughout the war.

D. A. Sutch has been appointed general superintendent of the Clinton, Massachusetts, plant of the Wickwire Spencer Steel Company, a division of the Colorado Fuel and Iron Corporation. Mr. Sutch, who has been works manager of the Wickwire Spencer Aviation Corporation, Newark, New Jersey, succeeds **G. G. Lloyd,** who was recently transferred to the Buffalo, New York, plant as general superintendent.

Jack L. Carmitcheal was elected vice president in charge of sales of the Lincoln Engineering Company, St. Louis, Missouri. Mr. Carmitcheal was formerly general sales manager for the company which manufactures lubrication equipment for industrial applications.

Carl J. Lamb has joined Hydropress, Inc., as a vice president. Mr. Lamb, who was on duty with the United States Naval Reserve with rank as captain, has had considerable experience as a consulting engineer. He was also district manager in the New York area for the Sharples Corporation, and had been a turbine engineer for the Westinghouse Electric Corporation for eight years.

Obituaries

Frank S. Lampard died recently in his 47th year. Mr. Lampard was an engineer for Mathews Conveyer Company, Ellwood City, Pennsylvania. He was well-known for his work in designing many outstanding conveying systems, especially in the metal working industries. He had very wide experience in the application of most types of conveying equipment, and specialized in the design of the special intricate mechanisms which are now a part of most every modern conveying system.

Orrin T. Allen died recently at his residence near Warsaw, Indiana, in his 64th year. He was a graduate of Armour Tech and became associated with American Steel and Wire Company as a sales engineer in 1909. He served as assistant manager of construction materials sales from 1918 to 1944 when he retired.

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TRADE MARK REGISTERED

IS

NON-FLUID OIL meets all the specifications of the ideal lubricant agreed on by ball and roller bearing manufacturers and is four ways better than ordinary lubricants because:

(1) NON-FLUID OIL does not require softening by frictional heat before it will feed, but instantly reduces friction between the balls or rollers and retainers — minimizing wear and power loss.

(2) Highly finished surfaces of balls and rollers are shielded by a constant film of lubricant from attack by moisture and acid fumes and thus protected from rust and corrosion.

(3) NON-FLUID OIL forms a perfect lubricating seal between the rotating shaft and housing to exclude dirt and moisture.

(4) NON-FLUID OIL is strictly neutral and does not develop free fatty acids in service. Stable in both use and storage, NON-FLUID OIL safeguards bearings and assures long, trouble-free service.

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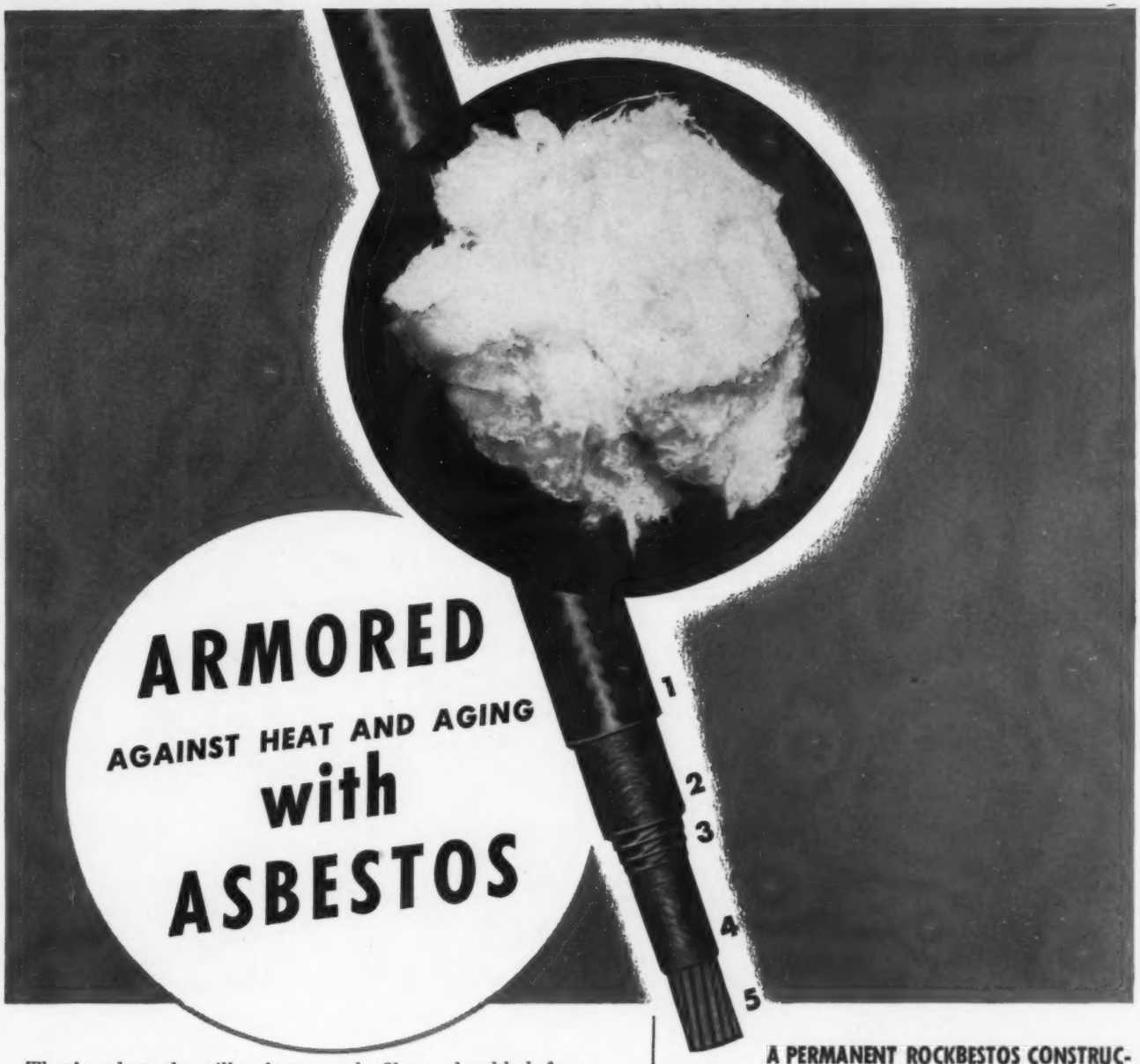

That's what the silky but tough fibres shredded from heatproof, fireproof, age-resistant crude asbestos do for Rockbestos A.V.C. wires and cables. They actually *armor* them against baking heat, oxidation, rotting fumes, oil, grease, and even flame, with insulation that is *practically indestructible!*

This permanent *asbestos insulation* gives you wires and cables that guarantee dependable operation of power, control and lighting circuits in high ambient temperatures—near boilers, steam lines, furnaces, kilns, soaking pits or in hot tunnels—and assures trouble-free performance of equipment that must function without failure even though it operates under severe conditions.

For *permanent installations* that practically eliminate maintenance and replacement use Rockbestos A.V.C. and All-Asbestos wires and cables—in 300 to 5000 volt ratings—single or multi-conductor—plain, lead sheathed or armored. Write for a catalog.

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2. Heat, flame and moisture resistant impregnated felted asbestos insulation that won't dry out, crack, flow or rot.
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4. Inner wall of impregnated felted asbestos withstands conductor-heating overloads and won't bake brittle or burn.
5. The conductor is perfectly and permanently centered in helically applied non-flowing insulation that provides greater current carrying capacity.

One of 125 different constructions designed by Rockbestos for severe or unusual operating conditions.

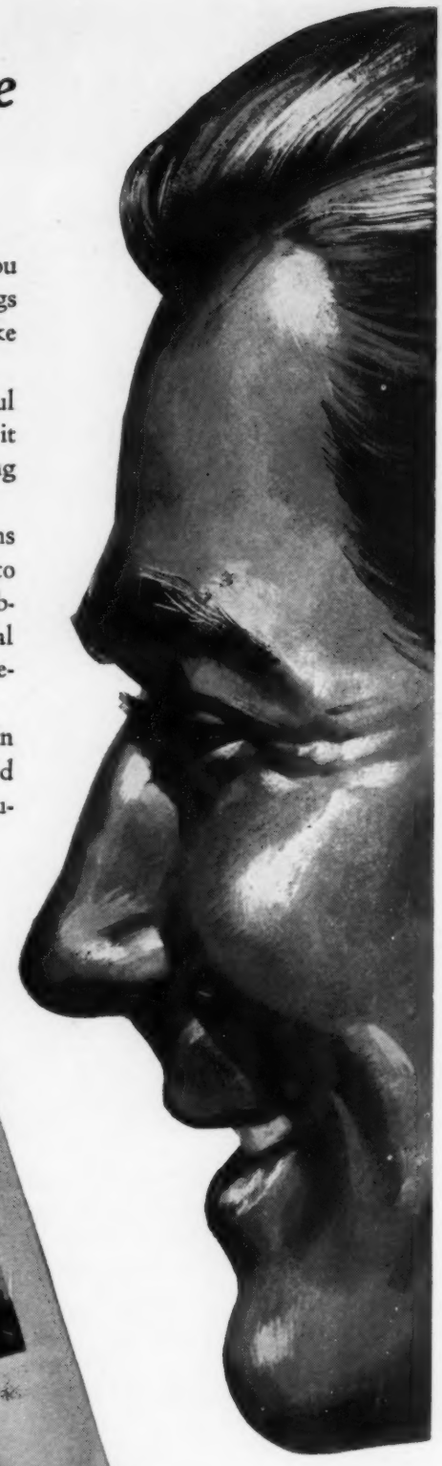
To help increase "Take-Home Savings"

THE Treasury Department has published two new booklets to help you and your employees realize the utmost benefit from your Payroll Savings Plan—benefits proportioned to the extent your employees add to "take home savings" by buying and holding U. S. Savings Bonds.

"Peacetime Payroll Savings Plan" for key executives offers helpful suggestions on the conduct of the Payroll Savings Plan. In addition, it quotes leaders of Industry and Labor and their reasons for supporting the Plan.

"This Time It's For You" is for distribution to employees. It explains graphically how this convenient, easy thrift habit works. It suggest goals to save for and how much to set aside regularly in order to attain their objectives. If you have not received these two booklets, or desire additional quantities, communicate with your State Director of the Treasury Department's Savings Bond Division.

See your Payroll Savings Plan through to maintain your share in America's future. It is sound economics and a powerful force for good today—and tomorrow—as a safeguard for stability and a reserve of future purchasing power—money that is kept within your community.



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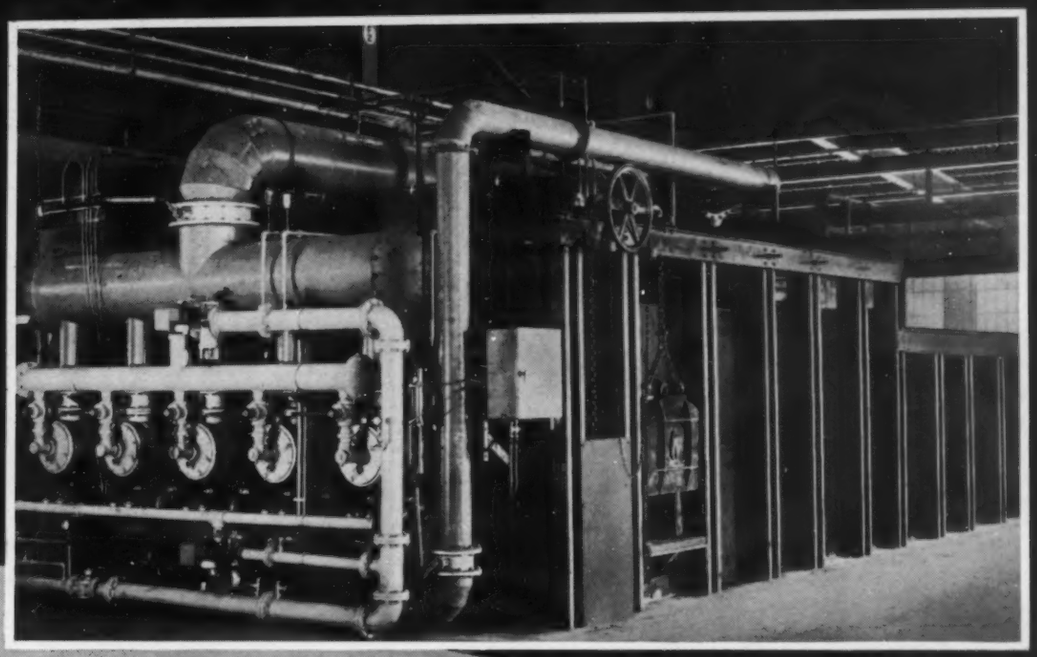

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Industrial furnaces
for quality heating and economical
performance to meet the particular requirements
of producers.

The Loftus Continuous Billet Heating Furnace pictured above is of end-charge and side-discharge design, equipped with top and bottom burners for end firing.

The larger top burners provide ample heat release for heating the billets. The smaller bottom burners insure proper holding and soaking. This furnace is automatically controlled throughout, and is constructed of selected first quality materials for rugged service.

Long experience in designing and constructing Continuous Ingot Heating Furnaces has resulted in impressive leadership in this field of engineering, which to you means equipment of sound modern design and assured efficiency.

Your inquiry will receive immediate attention.

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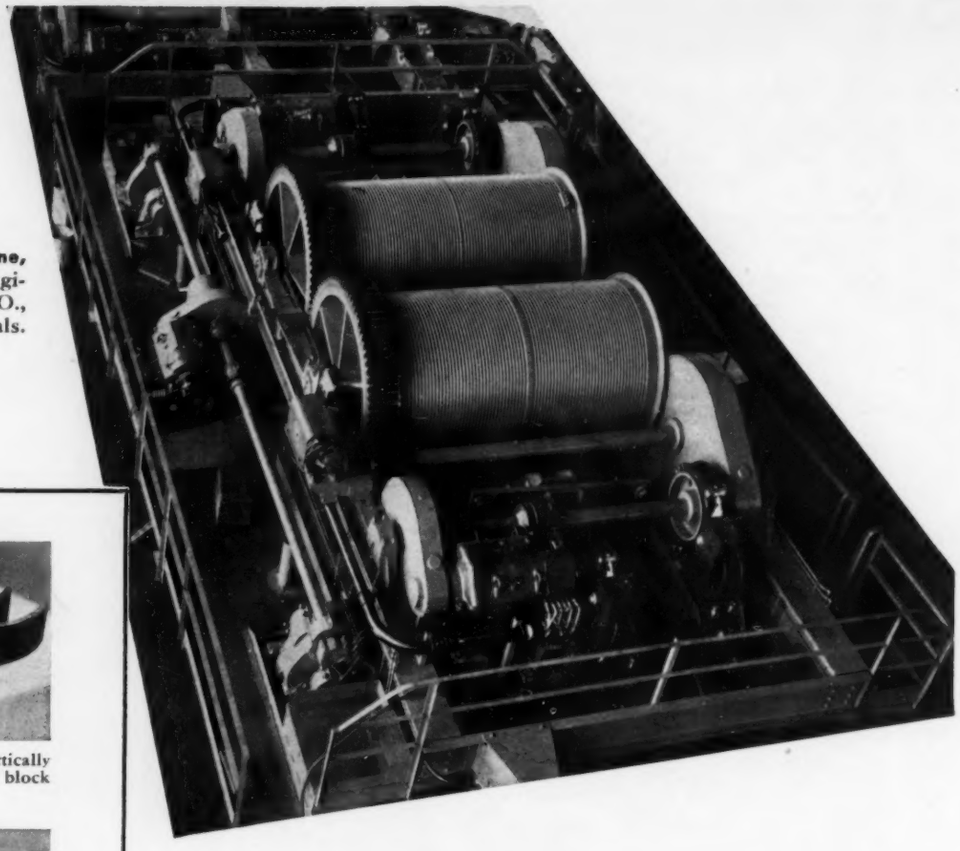
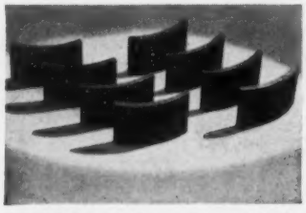
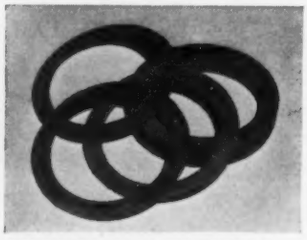


260-Metric Ton Ladle Crane, built by the Morgan Engineering Co. of Alliance, O., uses J-M Friction Materials.



J-M Friction Blocks . . . for practically all conditions where a rigid block material is required.



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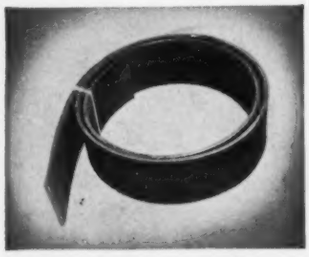

J-M Folded and Compressed Ground Lining . . . the standard general utility lining; semi-flexible; long wearing.

J-M Molded Friction Lining . . . Industry's Number One Molded Lining for long economical service.

J-M Friction Materials say:

"STOP and GO"

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When this powerful ladle crane operates it will lift and lower tons of weight *safely*—because it is equipped with Johns-Manville Friction Materials.

For over 60 years, the J-M label on friction materials has meant exceptional durability, high mechanical strength and resistance to heat and shock. Designed in the J-M Laboratory . . . and thoroughly tested under actual service conditions, these friction materials combine maximum braking efficiency with economical operation.

Today, these fine friction materials are serving leading steel mills on cranes and other equipment . . . efficiently and economically. For details about the complete line of J-M Friction Materials, or for special help on friction material applications, write Johns-Manville, Box 290, New York 16, N. Y.

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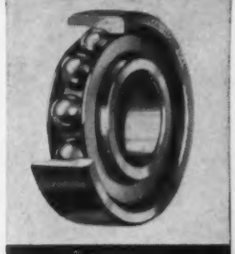
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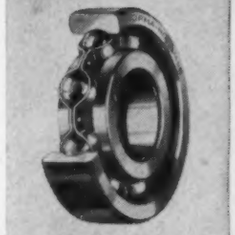
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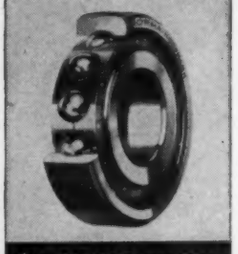
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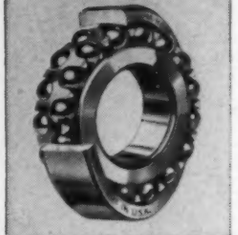
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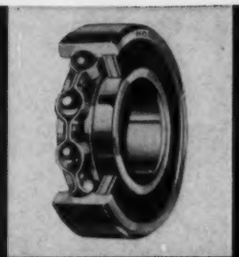
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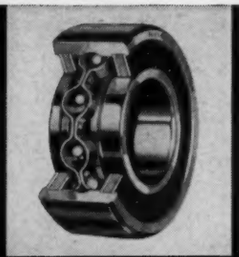
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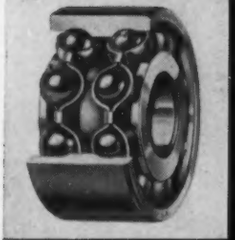
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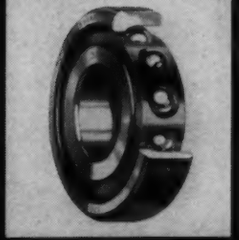
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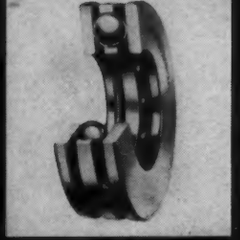
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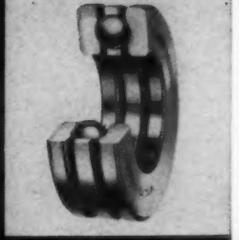
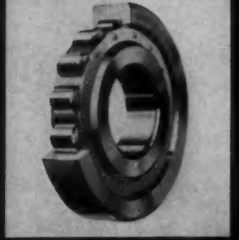
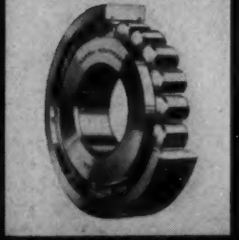
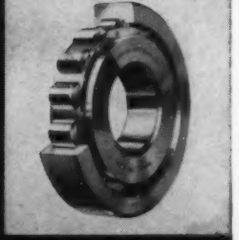

Single Direction Ball Thrust Bearing

Standard Cylindrical Roller Bearing


Type "E" Cylindrical Roller Bearing


Full Type (Retainerless) Cylindrical Roller Bearing

Extra Light Cylindrical Roller Bearing

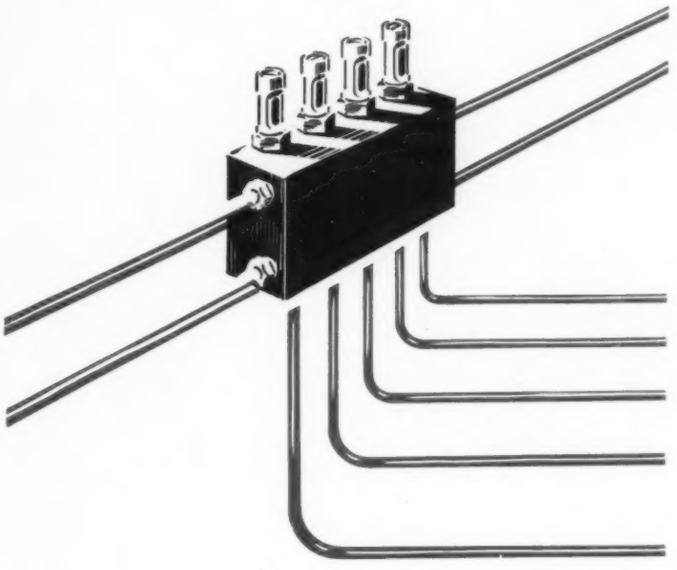

Two-Lipped Cylindrical Roller Bearing

2,000 Bearings
Lubricated in 5 Minutes

IN steel mills, bearing lubrication is no longer a problem when Farval centralized lubrication is installed. In one Indiana hot strip mill, a single Farval central station lubricates 2,000 bearings in five minutes—delivering the *right* amount—at the *right* time. No more hit-or-miss lubrication. Maintenance costs drop.

For example, the average life of a set of top roll bearings on a plate mill, was about 20,000 tons. After Farval was installed bearing life was increased 25 times. Half a million tons were rolled and the bearings were still on the job! Savings in brasses alone amounted to more than $15,000 per year, from an original investment of less than $3,000.

FARVAL—*Studies in Centralized Lubrication No. 77*



Farval delivers oil or grease under pressure to a group of bearings from one central station, in exact quantities, as often as desired. Farval is the Dualine System with the Positive Piston Displacement valve that has but two moving parts, with a Tell-tale at each bearing to show the job is done.

Comparable savings with Farval can be made on your equipment. Write for details.

THE FARVAL CORPORATION
3278 East 80th Street • Cleveland 4, Ohio
Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing.
In Canada: PEACOCK BROTHERS LIMITED

FARVAL
CENTRALIZED SYSTEMS OF LUBRICATION

GENERAL ELECTRIC

Announces...

NEW

Totally Enclosed TRI-CLAD MOTORS

In 1940, G.E. introduced the Tri-Clad open motor—with emphasis on the feature that industry wanted most in a motor, *protection.* Since then, more Tri-Clads have gone into service than any other integral-horsepower motor.

Today, we are ready with a new line of Tri-Clad motors—*totally enclosed, fan-cooled motors*—built on Tri-Clad design principles in both standard and explosion-proof types.

We believe that these are industry's most dependable motors. They are designed specifically for use in many adverse atmospheres—in iron dust, outdoors, in hazardous areas, and chemical atmospheres. Their scope of application is as wide as the field of industrial motor use. Safe-guarded against most sources of motor damage, their longer life and lower maintenance will make them economical motors for use on almost every job. *General Electric Company, Schenectady, N. Y.*

750-260-R030

1 to 1000 hp

COMPLETE ENCLOSURE FOR PROTECTION AGAINST DIRT, DUST, AND WEATHER